TEST ITEMS IN CHEMISTRY
FOR
CLASS-XI

Editor
M. Chandra

RTMENT OF EDUCATION IN SCIENCE AND MATHEMATICS
National Council of Educational Research and Training
Sri Aurobindo Marg
NEW DELHI-110016

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FOREWORD

Test evaluation is an integral part of the curriculum package. Development of test items is therefore an important responsibility of the curriculum developer. With this in view, the Department of Education in Science and Mathematics (DESM) has undertaken the task of developing test items in different subjects.

The present publication: Test Items in Chemistry for Class XI is an outcome of this general effort. The draft material was developed in two workshops and has been finalised and edited by Prof. M. Chandra. Prof. B. Ganguly, Head, DESM provided guidance for the proper execution of the project.

The National Council of Educational Research and Training (NCERT) is thankful to all those who have been associated with the preparation of this volume, which I hope will be of great use to the teachers and students of Class XI. The NCERT will be happy to receive suggestions for the improvement of this publication.

Dr. K. Gopalan
Director
National Council of Educational
Research and Training

New Delhi
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TEST EVALUATION IN CURRICULUM DEVELOPMENT : A FEW THOUGHTS

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In 1956, a Committee of College and University examiners in the U.S.A. published a "Taxonomy of Education Objectives" edited by Benjamin S. Bloom of the University of Chicago. In this taxonomy, objectives for any specific subject were classified into three domains - cognitive, affective and psychomotor. These domains bear considerable resemblance to the broad categories of knowledge, skills, attitude, interest.

More specifically, the cognitive domain includes those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills. It is this domain in which most of the work of curriculum development has taken place. The affective domain includes objectives which describe changes in interests and values and the development of appreciations and adequate adjustments. Psychomotor domain includes objectives related to changes in manipulative and motor skills.

Classification of Cognitive abilities

The objectives in the cognitive domain were further classified by Bloom in his Handbook-I, into a detailed classification scheme with illustrative test questions. Bloom's list refers to the classification in such a way that each new way of thought in the list involves all the previous ways of the list. The list worked out by Bloom is :

knowledge,
understanding (comprehension),
application,
analysis,
synthesis,
evaluation.

Knowledge : Knowledge is the ability to recall information that one has learnt. Knowledge has been recognised as of 3 categories -- Knowledge of : specific facts; of ways and means of dealing with specific facts; and of principles, generalization, theories and how they are related.

Understanding : Understanding (or comprehension) is the ability to interpret familiar information. Three categories of comprehension has been identified — that which involves translation of information from one form to another; that which involves recording, rearranging or looking at the material in a new way (also called interpretation - for example the task of distinction between a correct or incorrect result of an experiment); and that which involves predictions of information.

Application : Application is the ability to use knowledge and understanding in situations which may be somewhat unfamiliar, or where unfamiliar methods are used. E.g., one may be asked to apply somewhat abstract ideas such as principles, theories or laws which one knows and comprehends, to the interpretation of particular situations.

Analysis : Analysis involves the identification and sorting out of parts of a communication such as to clarify the communication. The three identified aspects of analysis are: the identification of the parts of a situation; recognition of the ways the parts are connected and interact; the identification of the principle or principles involved in bringing the parts together.

Synthesis : Synthesis is the ability to bring together several areas of knowledge and understanding, and transform them into a statement complete by itself. The three types of synthesis identified are: preparation of an essay or a statement which tries to communicate ideas, feelings or experiences in an organised or logical way; production of a plan or scheme of understanding a certain task (e.g. devising an experiment to test a hypothesis); production of a new idea by studying and bringing together in an original way previously unrelated facts or ideas.

Evaluation : Evaluation involves making judgement about the value of materials and methods for specific purposes. The evidence on which evaluation is based may come from either the situation itself (i.e. the situation is evaluated on its logic and internal consistency) or from outside the situation.

Analysis, synthesis and evaluation are the so called "higher abilities" and represent more complex thinking process. Most education achievement tests are concerned with the cognitive domain.[1]

One of the important uses of the test-evaluation procedure is to help teachers make the education objectives more complete and clear. As the . objectives become clearly defined, it is possible to make more realistic decision about their desirability and feasibility. Furthermore, as the objectives become increasingly specific and clear through the use of behavioural definitions and of operational definitions (i.e. actual test questions), it is possible for the teacher to begin to think of the kinds of learning experiences which are likely to help students grow in ways defined by the objectives. The teachers may also become more aware of the relevance or lack of relevance of these objectives of the learning experiences now available to students. Thus the very process of thinking about test and evaluation can help teachers to classify their educational objectives and improve the quality of their instructions.

Another effect of the test-evaluation instrument is to motivate students and to direct the ways in which they study and prepare. Questions devised could also require the students to think about the significant problems in contemporary life. Such questions may help students to find meaning and purpose in the study of the subject and help them to bridge the gap between the learning that goes on in the schools and the vital problems in the environment in which the students live. Thus, examinations are intricately interwoven with evaluation purposes and learning experiences, and it is impossible to consider one without the other. The development of the students is the goal of the learning process -- the instructional material, the teaching methods and the testing procedure being all means for these ends.[2]

The evaluation and judgement of teachers and the action which flows from these assessments are of vital importance to students in the higher secondary stage. Continual evaluation of the student by teachers and peers through formal examination and by less formalized processes, provides one of the major sources of information by which a student develops "self concept". The test-evaluation process at this stage of schooling influences the teacher's behaviour as well. The thoughtful teacher uses this information as a guide to the teacher's own teaching practice : what has been grasped by the students? What needs revision ? Who has failed to understand ? The teacher's self concept is therefore also being developed by the same test-evaluation procedure.[3]

Evaluation may reveal that certain curriculum objectives were not attained, and may suggest changed learning experiences or may even lead to the modification of objectives. Accurate assessment of education outcome is thus essential for sound planning and effective stimulation of growth in our education structure. Testing and assessment have always been integral aspects of curriculum development, and should thus be major responsibilities of curriculum workers.

Types of questions

Just a century ago, Horace Mann was influencial in replacing oral examination, then in vogue, with written ones. He argued that many questions asked uniformly of all students were fairer than a smaller numbers that varied from student to student. Until a generation ago, written essay type of tests were almost universally used. During the '20-s and '30-s, however, essay questions were increasingly subjected to attack, largely on grounds of the subjectivity of their scoring and their failure to yield diagnostic results. Too many irrelevancies were said to enter into the scoring process, and the final outcome was said to represent a blending of many diverse elements. The main recommended substitution was the so-called objective items. These kinds of questions were taken to eliminate variability in scoring -- although they are said to retain other variable elements such as the effects of guessing and of daring on the part of the students. To this day, both essay (or long answer type questions as they are often termed now), and objective questions have their advocates, and many are prone to debate their respective merits. This debate represents an over-simplified view of the issues involved, since each approach to test and measurement has strengths and weaknesses.[4]

Similarly controversies exist regarding the suitability of content type and application oriented questions. Although application oriented questions are often advocated since they are said to eliminate tendencies of rote learning among students, but it is not that content type of examinations have no validity whatsoever -- or that there is no legitimate place in tests for items that hold the students responsible only for recall, or for recognition of specific items of information. The case for the continued use of tests of this type rests primarily on two considerations : (i) some of the content of instruction in any subject is taught with the hope that it will be permanently retained by the student, and (ii) even with content which is primarily of immediate instructional value only, there is some positive correlation between the students' ability to recall this content and the extent to which the student has derived any generalised values from it and will retain them permanently.

Objective type tests

All objective type test items are divided into two main classes : the supply type and the selection type. In the supply type test items, students response by supplying the words, numbers or other symbols which constitute the

the response. Short answer type are often included in the supply type. Whereas, the true false, the multiple choice and the matching type questions represent the selection type — where students respond by selecting responses from among those presented in the item. Of course, both the long answer types and the objective type questions can include numerical problems.

The short answer form is often characterized by the presence of a blank on which the examinee writes the kind of answers called for by the direction, and can be of 3 basic varieties: the question variety, the completion variety, the identification or association variety.

The true-false form consists of a statement to be judged true or false, and is essentially a two response item in which only one of the possible alternatives is explicitly stated. This type also contains the right-wrong variety, the yes-no variety, the correction variety, the cluster variety.

The multiple choice form consists of : (i) the stem - or that part in which the task which the students have to undertake is set out together with any data which is necessary for the student to answers correctly; (ii) the response -- which refers generally to four or five possible ways in which students may answer -- the correct response being called the answer, and the incorrect responses the distractors. A single multiple choice item may possess the characteristics attributed to several distinct varieties such as : the best answers variety; the multuple response variety, the correct answers variety; the incomplete statement variety; the negative variety; the combined response variety.

The matching form of objective test exercise consists of a list of premises, a list of responses and directions for matching one of the responses to each of the premises. The two chief varieties of matching forms are the simple matching and that based on classification of statements.

The pictorial form of test items are based on pictures and graphical representation. These items are of two general types -- those in which the picture itself presents a problem in interpretation, and those in which the picture serves as an effective means of communicating ideas.

A few suggestions for developing test items

To understand the principles of development of test items one needs to consider the function of the different types of question items. The long answer type questions test students' power of expressing coherently a train of logical reasoning, their ability to choose the length of the answer, and their power of describing the kind of apparatus or the process involved. Tests with extended answer type questions thus get a higher premium on the power of expression. But in times of pressure, or stress, some students frequently fail to do themselves justice and fail even to realize what is required of them. A little "prompting" w may make a difference in such cases. Objectives tests may provide this prompting. Answer of one or two words can test knowledge of facts, answers of a line or two of writing can test power of generalization. Similarly, supply of missing words, selecting appropriate terms, or deleting the incorrect ones out of suggested alternatives which are special features of the objective type of questions can test application of knowledge and power of reasoning.

Every objective test item begins with an idea, which would consist of a statement identifying source of knowledge, understanding, ability or characteristic reaction of the examinee. The difficulty of obtaining item ideas depend on the nature of the item desired. If the purpose of the test is simply to determine whether or not the examinee possesses certain information, item ideas are obtained rather simply. If on the other hand, a serious effort is being made to measure understanding ability to interpret and evaluate materials and similar characteristics of the examinee, the task of obtaining item ideas is much more difficult.

The following suggestions could be considered as general guidelines for developing proper test items :

1. Items should be expressed as clearly as possible.
2. Only such words should be chosen, which have precise meaning; and complex or awkard word arrangements should be avoided.
3. All qualifications needed to provide reasonable basis for response selection should be included.
4. Non functional words should not be included.
5. Unessential specificity in the stem or the response should be avoided.
6. Irrelevant inaccuracies in any part of the item should be avoided.
7. The level of difficulty of the items should be adapted to the group and purpose for which it is intended.
8. Irrelevant clues to the correct response should be avoided.

9. In order to defeat the rote learner, stereotyped phraseology in the stem or the correct response should be avoided.

10. Irrelevant sources of difficulty should be avoided.

11. Suggestions for developing multiple choice items.

    a) Either a direct question, or an incomplete statement on the item stem should be used.

    b) In general, words that must otherwise be repeated in each response should be included in the stem itself.

    c) Negatively stated item stems should be avoided.

    d) All responses should be made grammatically appropriate to the stem.

    e) Responses that overlap or include each other should be avoided.

    f) "None of these" as a response should be used only in items to which an absolutely correct answer can be given. This response should be avoided as the answer to items in which it may cover a large number of incorrect responses.

    g) If the item deals with the definition of a term, it is often preferable to include the term in the stem and present alternative definition in the response.[5]

Concluding remarks

Assessment made by class teachers, internal examiners provide basic information which may lead to important decisions in the education process, affecting both the student and the teacher. Information from the test evaluation procedure may also lead to modification of curriculum objectives, and serve to guide learning experiences better. Thus, it will be proper to hope that improvement in test-evaluation processes will lead to improvement in the total instructional package.

The present publication : "Test Items in Chemistry for class XI" has been produced keeping in view this hope of improving the total instructional package. Based strictly on the NCERT Chemistry class XI textbook of July, 1988, the publication is basically divided into 3 parts. The first and the main body of the publication has the test items on the 19 units of parts I and II of the NCERT Chemistry text; followed by the "Keys" to all the items and finally the solutions of every numerical problem included in the test item. No question present in the exercise at the end of an unit in the text book has been included in the test items.

The present publication is meant for teachers as well as students. It is hoped that the test items would not only help the teacher assess the students' progress, but based on students' response, the test items could help the teachers improve the quality of their teaching and modify their ways of teaching if need be.

The students could find the test items useful in their effort to understand the subject and in their preparation for examinations; but the test items could also help the students develop a "self concept" and assist them with "self assessment". The paper setters and the examiners could also find the publication useful.

REFERENCES

1. Bloom (B.S) ed. Taxonomy of Education Objective. The Classification of Education Goals. Handbook I: Cognitive Domain. Longman Green Co.(1956)207 pp.
2. Bloom (B.S.) Evaluation in Secondary Schools, All India Council of Secondary Education (1958) 233 pp.
3. Dunn (S.S.) Measurement and Evaluation in Secondary Schools. Australian Council for Educational Research(1987) 131 pp.
4. Wilhers (T.T) Evaluation on Feedback and Guide. Association for Supervision of Curriculum Development, NEA (1967) 282 pp.
5. Lindquist (E.P) Educational Measurement. Americal Council of Education (1955) 808 pp.

UNIT - I

ATOMS, MOLECULES AND CHEMICAL ARITHMETIC

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice : Write the correct answer:

1.1 The number of significant figures in 0.001520 is :

a) 1
b) 3
c) 4
d) 6

1.2 The height of a person is 155.01 cm. The scale used for measurement has least count

a) 0.001 mm
b) 0.01 mm
c) 0.10 mm
d) 1.00 mm

1.3 The sum of 7.21, 10.245 and 0.0548 in terms of significant figures is :

a) 17.50
b) 17.509
c) 17.5098
d) 17.51

1.4 The S.I. unit of energy is :

a) kg m^2 s^{-2}
b) kg m^{-2} s^2
c) kg m^2 s^{-1}
d) kg m^2 s^2

1.5 Stainless steel is an example of an

a) element
b) homogeneous mixture
c) heterogeneous mixture
d) inorganic compound.

1.6 Which of the following forms part of the 7 basic SI Units ?

a) Joule
b) candela
c) newton
d) pascal.

1.7 Pure sample of water, irrespective of source, contains 88.89% oxygen and 11.11% hydrogen by mass. The data supports the

a) law of conservation of mass
b) law of constant composition
c) law of multiple proportion
d) law of reciprocal proportion

1.8 Which of the following can be deduced from Avagadro's hypothesis ?

a) 1 molecule of oxygen +2 molecules of hydrogen =
2 molecules of water vapour

b) 1 atom of oxygen +2 atoms of hydrogen =
1 molecule of water vapour

c) 1 atom of oxygen +2 molecules of hydrogen =
1 molecule of ice

d) 1 molecule of oxygen +2 atoms of hydrogen =
2 molecules of water (liquid)

1.9 Which of the following contains the maximum number of moles ?

a) 224 cm^3 of hydrogen at STP

b) 3.6 gm of water

c) 112 cm^3 of chlorine at STP

d) .12 gm of carbon.

1.10 Which of the following statements signifies equal number of molecules.

a) 5 gm of C_2H_4 and 2 gm of CH_4

b) 11.2 lit of H_2 at STP and 8 gm of N_2 at STP

c) 1 lit of CO_2 at STP and 1 lit of SO_2 at 273 K
and 101.325 kPa.

d) 0.1 mole of Na and 0.2 mole of Ca.

1.11 NaOH can be prepared according to the equation $Na_2CO_3 + Ca(OH)_2 \longrightarrow 2 NaOH + CaCo_3$. The amount of NaOH that can be obtained by using 1 kg Na_2Co_3 is

a) 0.755 gm

b) 7.55 gm

c) 75.5 gm

d) 755 gm

1.12 0.5 mole each of hydrogen sulphide and [illegible] mole of sulphur dioxide are mixed in a reaction flask. They react according to the equation $2H_2S + SO_2 \longrightarrow 2H_2O + 3S$. The mole of S formed in the reaction will be :

a) 0.5
b) 0.75

c) 1.50
d) 3.00

1.13 The number of gram atom in 8.0 gm of sulphur is

a) 0.15
b) 0.25
c) 0.35
d) 3.00

(B) Completion type items :

Complete the following:

1.14 a) 1 pico meter is ________ meters.
b) $kg/(ms)^2$ is the S.I. unit of ________.
c) A mixture of two miscible liquids [illegible] seperated out by the process of ________.

d) Cuprous oxide and cupric oxide contain copper in the ratio of 2:1 by mass with a definite mass of oxygen. The data supports the Law of ____________.

e) Atomic masses of elements can be accurately determined by a ____________.

.15 (a) A binary compound contains 50% A (Atomic mass-16) and 50%B (Atomic mass-32). The emperical formula of the compound is _______.

(b) Equal volumes of all gases contain same number of _______ under identical conditions of temperature and pressure.

(c) 2.86×10^{-7}m is equal to _____ nanometer.

(d) Unprocessessed milk is a ________ mixture.

(e) The constituents of grass extract can be detected by ________.

1.16 (a) The numbers 161 cm, 0.161 cm and .0161 cm all have _______ significant figures.

(b) In scientific notation, every number is written as $N \times 10^{n}$ where, N is a number with a single non_______ digit to the left of the decimal point and n is an _______.

(c) There are ________ basic S.I. units.

(d) The S.I units for luminous intensity is ___i)___ with the symbol ___ii)___.

(e) The molar mass in grams of any atom is numerically equal to its relative atomic mass in __________.

C **True and false type items:**

Classify the following [illegible] (T) and false(F):

1.17 (a) Brass is a compound of copper and zinc.

(b) Air is an element.

(c) Butter is a heterogeneous mixture.

(d) Ammonia is a compound.

(e) Blood is a homogeneous mixture.

1.18 (a) 1 lit = 10^{-3}m .

(b) 2.24 lit of hydrogen at STP contain 6.023×10^{23} molecules.

(c) Emperical formula of C_5H[illegible] is CH_2.

(d) A glucose solution which contains 1.8 g per litre has a molarity of .[illegible] mol/L. (Formula of glucose is $C_6H_{12}O_6$).

(e) Mass of 3.0115×10^{23} molecules of sodium (atomic mass 23) is 2.3 g.

1.19 (a) In addition and subtraction, the result should be reported to the same number of decimal places as that of the term with the least number of decimal places.

b) $3.75 - 0.0016 = 3.74$

c) The SI unit of temperature is celsius.

d) The SI unit of pressure is Newton

e) The SI unit of force can be represented by kg m/s^2

D **Matching type items:**

Match the items given in list A with relevant answers given in the list B by indicating the serial number of item of list A against that of list B.

1.20

	LIST A Mixture		LIST B Method of separation
a)	sulphur and sand	i)	chromatography
b)	sugar and iron filings	ii)	decantation
c)	salt solution	iii)	dissolution & filtration
d)	kerosene oil and diesel	iv)	evaporation
e)	blue and red	v)	magnetic separation
		vi)	fractional distillation
		vii)	gravity separation

1.21

	LIST A		LIST B
	Property		S.I. Units
a)	pressure	i)	kilogram
b)	temperature	ii)	mole
c)	mass	iii)	ampere
d)	amount of substance	iv)	Kelvin
d)	electric current	v)	Joule
		vi)	Pascal

1.22

	LIST A		LIST B
	Property		Law or theory
a)	Equal volumes of all gases contain equal number molecules at STP	i)	Gay-Lussac's law
b)	Atom is indestructible	ii)	Law of constant composition.
c)	All pure samples of the same compound contain the same elements combined in the same proposition by man.	iii)	Law of conservation of mass
d)	In chemical reactions the mass before and after the reaction remains unchanged	iv)	Dalton's atomic theory
		v)	Avagadro's Law

II SHORT ANSWER TYPE ITEMS

1.23 Carbon forms (a) Carbondioxide (b) Carbon monoxide. Show that their formation is in agreement with one of the laws of chemical combination. Indicate the Law.

1.24 Atomic mass of chlorine is 35.5 and it has two isotopes $^{35}_{17}Cl$ $^{37}_{17}Cl$. How will you account for this ?

1.25 One litre of hydrogen reacts with three litres of nitrogen to yield two litres of ammonia at STP. Show that the formula of ammonia is NH_3.

1.26 Balance the following equations :

(a) $Cl_2 + NaOH\ (conc) \longrightarrow NaCl + NaClO_3 + H_2O$

(b) $MnO_2 + HCl \text{ ---- } MnCl_2 + H_2O + Cl_2$

(c) $Cu + HNO_3\ (dil) \text{ ---- } Cu\ (NO_3)_2 + NO + H_2O$

(d) $K_2Cr_2O_7 + SO_2 + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

1.27 There is a mixture of three liquids A, B, C, having blue colour, no colour and red colour, with boiling points 373K, 350K and 373K respectively. Suggest a scheme for their separation .

1.28 There is a mixture of four solid substances A, B, C, D having the following properties : A and B are soluble in a liquid having different solubilities where as C and D are insoluble in the liquid. On heating, C directly changes into vapour without becoming liquid. Suggest a scheme for their separation.

1.29 In a hypothetical situation, three isotopes of carbon form hydrides under suitable conditions as follows:

(a) C_{12} forms C_2H_2 (b) C_{13} forms C_2H_4 (c) C_{14} forms C_2H_6. Is law of multiple proportion applicable ? Justify your answer.

III LONG ANSWER TYPE ITEMS

1.30 Two miscible liquids A and B boil at 373K and 353K respectively. Describe the method to be used to separate them. Draw a labelled diagram of the apparatus.

1.31 What is the law of multiple proportions ? Explain with two examples. How does this law point to the existance of atoms ?

1.32 There are two boxes of equal volume at the same temperature and pressure. Will they have equal number of particles where filled with

(a) nitrogen and oxygen
(b) sugar and salt ?

Justify your response.

1.33 Classify the following substances into elements, organic compounds, inorganic compounds, homogeneous mixtures and heterogeneous mixtures –

(a) nitrogen (b) air (c) brass (d) sugar (e) 24 carat gold (f) ten paisa coin (g) rock salt (h) smoke (i) tap water (j) iron nails.

IV NUMERICAL PROBLEMS

1.34 Calculate the molarity of 10% aqueous solution of sulphuric acid by mass if the density of the acid is 1.2 g ml^{-1}

1.35 A drop of water weighs 0.01 g. Calculate the number of molecules present in it.

1.36 If the charge present on one proton is 1.6×10^{-19} coulombs, calculate the charge present on 0.5 mole of proton.

1.37 An organic compound contains C = 50%, H = 13.3% and rest oxygen. What is the emperical formula of the compound ?

1.38 Calculate the number of moles and the number of molecules contained in 5.4 g of glucose. (Formula of glucose is $C_6H_{12}O_6$).

1.39 On the basis of the reaction —

$$Cu + 4\ HNO_3 \longrightarrow Cu(NO_3)_2 + 2\ NO_2 + 2H_2O$$

Calculate (a) the number of moles of $Cu(NO_3)_2$ formed from 1 mole of nitric acid

(b) the number of moles of NO_2 obtained from 0.5 mole of copper.

1.40 Calculate the mass of one atom of iron in gm, if its atomic mass is 55.8.

1.41 How many moles of hydrogen will be formed by reaction of 1.15 g of sodium with excess of water ?

1.42 1.0 mole of zinc was treated with 1.5 moles of hydrochloric acid. How many moles of hydrogen were formed and which reactant was left unreacted ?

1.43 How many gms of silver chloride will be formed by reacting 0.1 mole of silver nitrate and 0.5 mole of sodium chloride solution ?

1.44 a) How much calcium carbonate is required to produce 0.112 litre of carbondioxide at STP ?

b) Calculate the number of molecules of carbondioxide produced ?

1.45 If the cost of sugar and that of common salt per mole is Rs.2.03 and Rs.0.07 respectively, find the cost of sugar and salt per kg. (Formula of sugar is $C_{12}H_{22}O_{11}$).

1.46 Given the atomic masses of Fe = 55.8, S = 32 and O = 16 amu. What is the percentage composition of $Fe_2(SO_4)_3$?

1.47 A sample consisting of 100 mls of 2M HCl is mixed with 150.0 cm^3 of 3.00 M HCl. What would be the concentration of the final solution ?

1.48 What is the simplest formula of a compound which consists of 7.0 gm of nitrogen for each gram of hydrogen ?

1.49 What is the molecular mass of a compound if 2.0115×10^9 of its molecules weigh 1.0×10^{-12} g ?

1.50 The isotopic distribution of potassium is 93.2% 39_K and 6.8% of 41_K. How many 39_K atoms are there in 1 gram atom of potassium ?

1.51 Which of the following has the largest numbers of molecules ? Justify by calculation.

a) 224 cm^3 of hydrogen at STP

b) 28 gm of nitrogen at STP

c) 3.2 gm of oxygen at STP

d) 4.8 gm of carbon.

UNIT - 2

ELEMENTS THEIR OCCURENCE AND EXTRACTION

I. OBJECTIVE TYPE ITEMS

(A.) Multiple choice type. Write the correct answer:

2.1 The most abundant element in the earth's crust is:

a) silicon

b) carbon

c) oxygen

d) nitrogen

2.2 The element that is recovered commercially from sea water is:

a) Na

b) K

c) Ca

d) Al

2.3 The aluminothermic process is used for the reduction of:

a) Fe_2O_3

b) Al_2O_3

c) Cu_2O

d) ZnO

2.4 Haemetite is:

a) iron sulphide

b) manganese di oxide

c) calcium carbonate

d) iron oxide

2.5 The process of "roasting" is represented by the equation:

a) $CaCO_3 \longrightarrow CaO + CO_2$

b) $4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$

c) $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

d) $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$

2.6 By allowing the crushed ore to flow in a current of water, the lighter impurities can be washed away, leaving behind heavier particles containing the mineral . This process if called:

a) froth floatation

b) smelting

c) levigation

d) leaching

2.7 Magnetite has the formula:

a) Fe_2O_3

b) $MgCO_3 . CaCO_3$

c) $Fe_2O_3 . FeO$

d) $CaSiO_3 . 3MgSiO_3$

2.8 In qualitative analysis, the separation of metal ions is based on their

a) atomic mass

b) atomic number

c) oxidation state

d) solubility characteristics.

2.9 A black percipitate is obtained when H_2S is passed through a dilute acidic (HCl) aqueous solution containing.

a) Cu^{2+} and Pb^{2+}

b) Zn^{2+} and Mg^{2+}

c) Mg^{2+} and Fe^{3+}

d) Mg^{2+} and Ni^{2+}

2.10 Froth floatation method is used for the concentration of ores which are:

a) oxides

b) sulphides

c) halides

d) carbonate

2.11 Leaching is a process in which:

a) a particular mineral in an ore is dissolved selectively by using acids bases or other reagents.

b) pieces of ore are made to float by bubbling air through water containing crushed pieces of mineral

c) lighter impurities are washed away in a current of water

d) impurities from a mineral are removed by melting

(B.) Completion type items Complete the following:

2.12 The mineral from which the metal can be obtained commercially is called its ____________.

2.13 The element found in sea weeds in abundance is ____________.

2.14 Sulphide ores are usually concentrated by the ____________ process.

2.15 Sodium, potassium, magnesium and aluminium are some of the metals obtained by the ____________ method.

2.16 The waste material in an ore is called the ____________, which is mostly ____________.

2.17 The beneficiation process is employed to ____________ an ore.

2.18 The metal is haemoglobin is ____________.

2.19 In the extraction of gold and silver, leaching is based on the principle of ____________.

C. True and False type items

Classify the following statements as true (T) and false (F).

2.20 i) Elements for which the charge/size ratio is less than 4, (eg Na^+, Mg^{2+}, K^+) are easily extracted into water (sea water).

ii) Chemical weathering affects the nitrogen cycle and the carbon cycle.

iii) Copper, tin, mercury are familiar because they are the more abundant elements.

iv) Cooling of the gaseous matter resulted in formation of different zones in the order: a metallic zone, a silicate zone, a sulphide layer.

v) The metallic core is called the lithophil.

2.21 i) Magnetite is Fe_2O_3 .

ii) Iron pyrite is a carbonate of iron.

iii) Dolomite is a mixed carbonate of two metals.

iv) Sea weeds are an important source of iodine.

v) Sea water contains as many as 15 elements all of which can be recovered commercially.

(V) Matching type items

2.22 Match the items given in List A with relevant answers given in list B by indicating the serial number of item of List A against that of List B.

List A ore	List B type of ore
a) haematite	i) sulphide
b) malachite	ii) silicate
c) asbestos	iii) carbonate
d) cinnabar	iv) oxide
	v) sulphite

	List A element		List B ore
2.23 a)	aluminium	i)	pyrolusite
b)	magnesium	ii)	malachite
c)	mercury	iii)	magnetite
d)	copper	iv)	cinnabar
e)	calcium	v)	bauxite
f)	manganese	vi)	calcite
		vii)	asbestos

II. SHORT ANSWER TYPE ITEMS

2.24 Name some of the elements which are accumulated in living organisms and which are concentrated in different parts of living beings.

2.25 Generally sulphides are converted into oxides before reduction.Why is it necessary ?

2.26 Why is leaching of gold by metal cyhnides carried out in presence of oxygen ?

2.27 Of the metals Ca, Pb, Al, Cu,which is extracted from its ore by electrolytic method, and why ?

2.28 What is the principle of "zone refining"?

2.29 Although a metal to be extracted is present in a numbers of minerals, but all minerals are not called the ore of the metal.Why ?

2.30 Why is the electrolytic method used to reduce Al_2O_3 to Al , instead of the chemical reduction method?

2.31 How does hot charcoal help in obtaining a metal from its oxide ? Give an example.

IV LONG ANSWER TYPE ITEMS

2.32 Comment on the statement "sea is a major source of elements".

2.33 Give examples of various reduction process carried out in obtaining metals from their oxide and sulphide ores.

2.34 Birefly state the main steps worked in extraction of metals. Give suitable examples.

2.35 Explain and illustrate the following terms:

a) roasting
b) chemical leaching
c) smelting

2.36 Discuss two methods employed in the refining of metals, give suitable examples to illustrate your answer.

2.37 a) Lithosphere is one of the 3 shells the earth is made of Name the other two.

b) Igneous rocks is one of the three kinds of rocks the earth's crust in made of. Explain the process by which igneous rocks might have formed.

c) i. Name a metal which occurs in combined state in sea water.

ii. Draw a labelled diagram showing the electrolytic extraction of the above metal.

iii. Name the electrode at which the metal is likely to deposit.

4 iv. Write the equation showing the reduction of the ion to the metal.

d) i) Choose a coinage metal which occurs in combined state and name two of its important ores.

ii) List the steps which will be employed in sequence to extract the metal in pure form from one of the ores named by you.

iii) Write the equation for the chemical reaction (if any) involved in the above metallurgical process.

IV PROBLEM TYPE ITEMS

2.38 An element A is highly reactive. It burns in chlorine to form a chloride, which is highly soluble in water and the solution is neutral to litmus. This element is essential for the survival of living organisms.

Suggest:

a) Whether it is a metal or a nonmetal;

b) Whether it can be found in nature in native state or in combined state;

c) the group to which it may belong in the periodic table

d) a method for its isolation from its chloride.

2.39 Sea water contains chlorides of sodium, magnesium and calcium. Suggest a method for their separation. You are provided with the following information:

a) Chlorides of alll the three are highly soluble.

b) Carbonates of magnesium and calcium are insoluble.

c) In presence of excess ammonium ions magnesium is not precipitated as carbonate.

2.40 An element in bivalent form is available as a green mineral. This is sparingly soluble in water. On treatment with acid, it liberates a gas which turns lime water milky. The acid solution gives black precipitate of a sulphide on passing H_2S through it. Name the mineral.

UNIT III

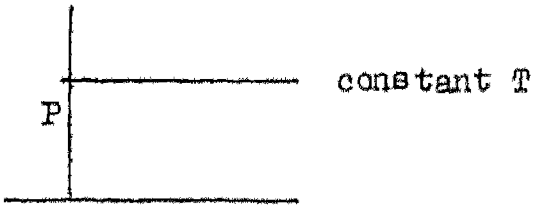
STATES OF MATTER

I OBJECTIVE TYPE ITEMS

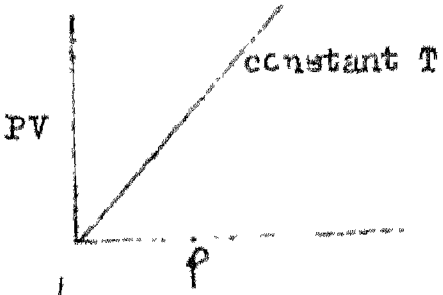
(A) Multiple Choice Write the correct answer :

3.1 Which one of the following diagrams correctly describes the behaviour of a fixed mass of an ideal gas ?

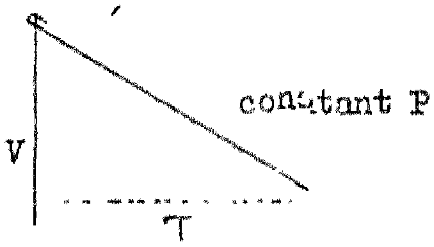
a)



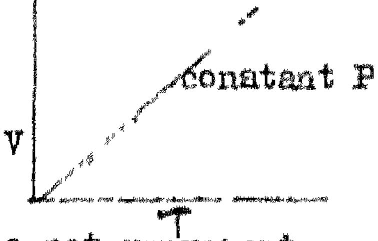
b)



c)



d)



3.2 Which of the following expressions does not represent Boyle's law ?

a) PV = constant

b) $V \propto \frac{1}{P}$

c) $V_1T_2 = V_2T_1$

d) $P_1V_1 = P_2V_2$

3.3 Charle's law gives a relation between :

a) volume of a gas and the number of moles of the gas
b) volume of a gas and its pressure
c) volume of a gas and its temperature
d) pressure of a gas and the number of moles of the gas.

3.4 Real gases deviate considerably from ideal behaviour at high pressures and low temperatures. This is because under these conditions the factors:

a) $\frac{a}{V^2}$ and "b" are not negligible

b) $\frac{a}{V^2}$ is negligible but "b" is not.

c) $\frac{a}{V^2}$ is not negligible but "b" is.

d) $\frac{a}{V^2}$ and "b" are both negligible.

(Note : $\frac{a}{V^2}$ is the term that corrects the deviation on pressure while the term "b" corrects the volume).

3.5 When a meter long glass tube closed at one end and filled with mercury is inverted in a dish containing mercury, the level of the mercury in the tube drops till :

a) all the mercury runs out of the tube into the dish

b) the pressure acting downwards due to the mercury column in the tube is equal to the atmospheric pressure

c) the pressure acting downwards due to the mercury column in the tube is less than the atmospheric pressure

d) the pressure acting downwards due to the mercury column in the tube is more than the atmospheric pressure.

3.6 Which of the following statements is not an assumption of the kinetic theory of gases :

a) Actual volume of molecules is negligible compared to the empty space between them.

b) The particles of a gas are in a state of continuous motion.

c) There are no attractive forces between the particles.

d) At any particular time, different particles in a gas have the same kinetic energy.

3.7 Which of the following statements regarding vapour pressure of a liquid is incorrect ?

a) vapour pressure of a liquid has a characteristic value at a given temperature.

b) The number of molecules escaping from the surface of the liquid increases with increase in temperature.

c) The number of molecules escaping from the surface of a liquid increased with increase in pressure.

d) At the boiling point, the vapour pressure of the liquid is equal to the atmospheric pressure.

3.8 Which of the following statements about evaporation of a liquid is incorrect ?

a) Liquids evaporate when left open to the atmosphere.

b) This process of evaporation results in cooling of the liquid.

c) Evaporation is accelerated by large surface area.

d) Evaporation supports the fact that particles in a liquid does not have any attractive force amongst each other.

3.9 Which of the following does not explain the nature of liquids in terms of the kinetic theory ?

a) There is an appreciable attractive force between the molecules.

b) The molecules are relatively close together and are in constant, random motion.

c) The attractive force between the molecules is weak.

d) The average kinetic energy of a molecule in a given sample is proportional to the absolute temperature.

3.10 Experimental evidence indicates that crystals of iodine are made up of many molecules with the formula I_2. The type of bond holding the molecules together within the crystal is :

a) ionic
b) vonder Waals
c) covalent
d) polar

3.11 One characteristic feature of ionic compounds is that ;

a) they are the only substances which form crystals
b) they are formed by few elements of the first three groups of the periodic table only
c) they are good conductors of heat and electricity
d) they always form brittle solids of high melting point.

3.12 Height of the mercury column in a barometer dropped from 0.76 m to 0.74 m just before a dust storm. The pressure in kilopascal goes down by

a) 2.6 kPa
b) 2.0 kPa
c) 74.0 kPa
d) 76.0 kPa

3.13 A mixture of ideal gases A, B and C contain :

n mole of A at partial pressure p_A ,
2n " " B " " " p_B ,
3n " " C " " " p_C ,
The total pressure P is given by :

a) $P = p_A + p_B + p_c$

b) $P = p_A + 2p_B + 3p_c$

c) $P = p_A + p_B^2 + p_c^3$

d) $P = \frac{p_A + 2p_B + 3p_c}{6}$

3.14 Use of hot air balloons for meteorological observations is possible because :

a) density of hot air is comparable with the density of oxygen which is an important component of air

b) density of hot air is comparable with the density of nitrogen which is a major constituent of the atmosphere.

c) gases expand on heating and become less dense and rise displacing cooler air of higher density

d) composition of air changes on heating resulting into lowering of its density.

3.15 The equation $(P+\frac{a}{V^2})(V-b)=RT$ for one mole of gas will be reduced to $PV = RT$ when

a) pressure and temperature both are high

b) pressure is low and temperature is high

c) pressure is high and temperature is very low ,

d) pressure and temperature are both low.

3.16 A balloon filled with 5 litres of a gas was taken to a depth of 10 metres in a lake. Assuming density of water as 1 g/cm^3, the volume of the balloon will be:

a) 0.5 L

b) 2.5 L

c) 5.0 L

d) 10.0 L

3.17 Two gases XY_3 and Z_2 react completely in presence of a catalyst to give gaseous products. If the resulting increase in volume is about 11%, which of the following is the correct equation ?

a) $2XY_3 + 3Z_2 \longrightarrow XZ + XZ_2 + 3Y_2Z$.

b) $4XY_3 + 3Z_2 \longrightarrow 2X_2 + 6Y_2Z$

c) $4XY_3 + 5Z_2 \longrightarrow 4XZ + 6Y_2Z$

d) $2XY_3 + Z_2 \longrightarrow 3Y_2 + 2XZ$.

3.18 Silver metal crystallises in the cubic close packing (ccp) structure. The coordination number of silver will be :

a) 4
b) 6
c) 8
d) 12

3.19 Experimentally it is found that calsium chloride has a body centred cubic lattice. In this structure each calsium ion is surrounded by :

a) four chloride ions
b) six chloride ions
c) eight chloride ions
d) twelve chloride ions

3.20 Copper has got face centred cubic unit cells. The number of copper atoms per unit cell is:

a) 2
b) 4
c) 6
d) 12

3.21 The boiling points of water, pentane, carbon disulphide and ethanol are 373K, 309K/319K, 351.5K respectively. The intermolecular forces will be in the order :

a) water ethanol carbon disulphide pentane

b) carbon disulphide pentane ethanol water

c) pentane carbon disulphide ethanol water

d) ethanol water pentane carbon disulphide.

B Completion type items

Complete the following :

3.22 Given three solids A, B, C. Supply wherever possible information missing from the table :

Characteristics	A	B	C
Type of solid	molecular	___ iii) ___	___ v) ___
Melting point	___ i) ___	___ iv) ___	high
Hardness	soft	very hard	brittle
Electrical properties	___ ii) ___	non conductor	___ vi) ___

3.23 Ether evaporates more readily than alcohol and alcohol evaporates quicker than water. The intermolecular attractive forces vary in the order ether ___ i) ___ alcohol ___ ii) ___ water.

3.24 Although boiling and evaporation are similar processes they differ in some respects. While evaporation occurs spontaneously at __i)__ temperature, boiling takes place only at a __ii)__ temperature.

3.25 a) Boiling point of water at the top of a hill will be ______ than the boiling point of water at sea level.

b) When some impurity is added to any solid, its melting point ______.

c) Vapour pressure of a liquid will ______ with the gradual increase in temperature of liquid.

d) Full form of SI unit is ____________.

C True and false type items

Classify the following statements as true (T) and false (F).

3.26 a) Melting points are often taken to be a measure of the strength of the lattice.

b) There is intermolecular force between gas molecules.

c) Unit of pressure is Newton.

d) Boyle's law also holds good at very high pressures.

e) Absolute scale of temperature is equal to the sum of degree Celsius and degree Kelvin.

f) Gas enclosed in a container exerts equal pressure on the walls of the container.

(D) **Matching type items**

Match the items given in list A with the relevant answer given in list B by indicating the serial number of items of list A against that of list B.

3.27

	LIST A definition of:		LIST B expression
a)	pressure	i)	$\frac{PV}{nRT}$
b)	compressibility	ii)	$PV = RT$
c)	ideal gas	iii)	hdg
d)	Bragg's law	iv)	$n\lambda = 2d\sin\theta$
		v)	$(P+\frac{a}{V^2})(V-b) = RT$

3.28

	LIST A name of scientist		LIST B relation derived
a)	Robert Boyl.	i)	V = constant x no. of moles
b)	Jacques Charles	ii)	PV = constant
c)	John Dalton	iii)	$(P+\frac{a}{V^2})(V-b) = RT$
d)	Amedeo Avagadro	iv)	$P = \frac{mg}{A}$
e)	van derwaal	v)	$\frac{V_1}{V_2} = \frac{T_1}{T_2}$
		vi)	$P_T = P_1+P_2+P_3$ ....

II SHORT ANSWER TYPE ITEMS

3.29 No matter how much heat you put under a pan of water on a stove, you cannot heat it above its boiling point. Why ?

3.30 How can you account for the fact that the normal boiling point of HF is higher than that of HCl, while boiling point of F_2 is lower than that of Cl_2 ?

3.31 Why does water boil at a lower temperature at the mountain top than at the seashore ?

3.32 One of the assumptions of the kinetic theory of gases is that collision between the particles is elastic. How do you support this assumption ?

3.33 Peredict what will happen if the volume of a fixed amount of a gas is increased at constant temperature. Please explain on the basis of the molecular model.

3.34 Apply the Maxwell Bolzmann distribution to molecular velocities of gas particles.

3.35 Can you make a liquid boil at any desired temperature? If so, how ?

3.36 If a substance decomposes at its normal boilding point, what will you do to make it boil without decomposition ?

3.37 The assumption that there is no intermolecular force between gas molecules is not strictly true. Name two common phenomenon for gases that support this statement.

3.38 Though gases and liquids are both termed as fluid but when compared in terms of compressibility, liquids are found to be almost incompressible, while gases are not. How do you explain this ?

3.39 Vapour pressure of water at 298K, 308K and 318K is 24 mm Hg, 42 mm Hg and 72 mm Hg respectively. Account for the rise in vapour pressure.

3.40 Values of normal boiling points of

NH_3, CCl_4 , Br_2 , Au , O_2 are :

307K, 350K, 331K, 323K, 90K respectively.

Identify the liquids which will have the highest, and the lowest vapour pressures respectively at room temperature (298K).

3.41 Explain why food material are cooked more rapidly in a pressure cooker than in an ordinary pot.

3.42 Predict which of the following compounds will have greater surface tension.

$CH_3OCH_2CH_3$ (methyl ethyl ether), $CH_3CH_2CH_2OH$ (n-propanol). (Hint : in n propanol there is hydrogen bonding, which is not possible in case of ether).

3.43 At room temperature, vapour pressure of acetone, dichloromethane and water are 495 mm Hg, 750 mm Hg and 55 mm Hg. Arrange the compounds in order of increasing normal boiling points.

3.44 The time required for 5 ml of ethanol and 5 ml of acetone to flow through a fine glass tubing is 80 seconds and 20 seconds respectively. Which of the two liquids has greater viscosity ?

III LONG ANSWER TYPE ITEMS

3.45 In what way is an amorphous solid different from a crystalline solid ? Illustrate your answer with examples.

3.46 What are the different types of bondings in solids? Explain the properties of solids on the basis of the bondings.

3.47 Explain how each of the following gives an indication of the strength of the intermolecular forces in a liquid

a) surface tension
b) vapour pressure
c) viscosity
d) boiling point

3.48 Explain the reason for the following :

a) Viscosity of liquids decreases when temperature is raised.
b) Liquids are much less compressible than gases.
c) Mercury drops tend to attain spherical shapes.
d) Solids are almost incompressible.

3.49 Explain whether a gas behaves ideally or deviates from ideal behaviour if :

a) it is compressed to a smaller volume at constant temperature,

b) temperature is raised keeping the volume constant,

c) more gas is introduced in the same volume at the same temperature.

3.50 Maxwell Boltzmann distribution law is applicable in case of gases. Do you feel that this can be equally useful in case of distribution of velocities for liquids as well? If so, based on a distribution curve, can you explain why an evaporating liquid becomes cool?

IV NUMERICAL PROBLEMS

3.51 Two bulbs A and B are kept at constant temperature. Bulb A contains 1 m^3 of hydrogen at 202.6 kPa pressure and bulb B contain 4 m^3 of hydrogen at 101.3 kPa pressure. The two bulbs are connected to each other. Calculate,

i) which gas has a higher partial pressure.
ii) the total pressure.

3.52 What will be the density of CO_2 in kg/m^3 at 323 K and 101.3 kPa pressure ?

3.53 Determine the approximate molecular mass of a gas, if 0.56 dm^3 weigh 0.0015 kg at STP.

3.54 Compute the approximate density of CH_4 at 294 K and 506.625 kPa.

3.55 How many molecules of an ideal gas are there in 1×10^{-3} dm^3 at STP ?

3.56 The measured density (at STP) of He is 0.1784 kg/m^3 what is the weight of 1 mole ?

3.57 Same price is being charged for :

a) 0.1 dm^3 of the gas at STP (b) 10 dm^3 of the gas measured at 1.3 k Pa pressure at 423 K. Which offer would you accept ?

3.58 Which will contain more molecules ? 40×10^{-3} kg of H_2O or 60×10^{-3} kg of NaCl ?

3.59 Calculate the root mean square velocity of oxygen molecule at 300 K.

3.60 2 dm^3 of a gas "x" at 20.65 k Pa and 2 dm^3 of a gas "Y" at 40.53 k Pa are mixed at constant temperature. If the final volume is 2 dm^3, what will be the pressure of the mixture ?

3.61 Nitrogen, oxygen and argon are the three abundant gases present in the atmosphere. If their mole fraction ratios are 0.781, 0.209 and 0.0[illegible] respectively, calculate their partial pressure in kPa in a sample collected at the sea level.

3.62 ΔH of sublimation of ice at 273 K is 57.[illegible] kJ/mol of H_2O. When compared to non-hydrogen - bonded solids having inter molecular (vander Waals forces) similar to those found in ice, the ΔH of ice (if it did not have hydrogen bonding), is estimated to be 1[illegible] kJ/mol. From these data, estimate the strength of hydrogen bond in ice.

3.63 How many millimoles of H_2SO_4 are represented by 2×10^{18} molecules of H_2SO_4 ?

3.64 Metallic gold crystallises in face centered cubic lattice. The length of the cubic unit cell is a = 4070 pm. What is the closest distance between gold atoms ?

3.65 Aluminium metal at 293° has a density of 2.70×10^3 kg/dm^3. It crystallises in a face centered cube form that represents close packing of spheres. In such an arrangement there is 25.9% void space. What is an approximate diamdter of a Al atom ? (at wt of Al = 27 amu).

3.66 A silver crystallises in a face centered cubic structure as shown in the given figure. If the radius of the silver atom is 144.5 pm, what is the length of the face diagonal and the edge length of the unit cell?

3.67 TheNaCl crystal is made up of planes that are 397 pm apart. If an X-ray beam with a wave length of 154 pm strikes this set of planes, at what angle will a diffraction pattern be observed?

UNIT - 4

ATOMIC STRUCTURE

I. OBJECTIVE TYPE ITEMS

(A.) Multiple choice : Write the correct answer.

4.1 Rutherford's experiment of scattering of alpha particles showed for the first time that an atom has :

a) electrons

b) protons

c) neutrons

d) a neucleus

4.2 The time required to pass 36000C through an electroplating both using current of 5A is :

a) 0.2 hrs

b) 0.72 hrs

c) 2 hrs

d) 7.2 hrs

4.3 The value of e/m of an electron was measured by :

a) Millikan

b) J.J. Thomson

c) Dalton

d) Rutherford

4.4 The atomic number of an element is 11 and its mass number is 23. The respective number of electrons, protons and neutrons in this atom will be :

- a) 11, 11, 12
- b) 11, 12, 11
- c) 12, 11, 11
- d) 23, 11, 23

4.5 For the electron to remain in its orbit the electrostatic attraction between the electron and its nucleus must be equal to its :

- a) binding energy
- b) centrifugal force
- c) ionization potential
- d) electronegativity

4.6 The specific state of an electron in an atom is given by :

- a) its atomic number
- b) its quantum number
- c) the number of electrons in the outermost orbit
- d) the total number of electrons

4.7 An atom which has a mass number of 14 and has 8 neutrons, is an :

- a) isotope of oxygen

- b) isobar of oxygen
- c) isotope of carbon
- d) isobar of carbon

4.8 Which of the following has an equal number of neutrons and protons ?

- a) hydrogen
- b) deuterium
- c) flourine
- d) chlorine

4.9 Representatives of which class of the following differ in chemical properties ?

- a) isotopes
- b) isobar
- c) allotropes
- d) both isotopes and allotropes

4.10 Photoelectric emission from a metal surface commences when the incident light has :

- a) any frequency
- b) a threshold frequency
- c) an optimum velocity
- d) any intensity

4.11 The wavelength of visible spectrum ranges in

a) 300 nm to 800 nm

b) 400 nm to 750 nm

c) 300 nm to 750 nm

d) 400 nm to 800 nm

4.12 Identify the incorrect statement regarding atomic emission/absorption spectrum :

a) Atomic spectrum is useful for identifying elements.

b) Chemical analysis to identify and estimate elements present in a sample can be done with the help of atomic spectra.

c) Atomic spectra have very sharp discrete wavelengths.

d) Atomic spectra are generally band spectra.

4.13 The dimension of the Rydberg constant is that of :

a) reciprocal length

b) luminous intensity

c) electric current

d) temperature

4.14 Cathode ray experiment is conducted in a discharge tubes containing 4 different gases A, B, C, D. If the molecular weight of A=B D C, then the e/m as observed will be :

a) $\frac{e}{m}A > \frac{e}{m}B > \frac{e}{m}D > \frac{e}{m}C$.

b) $\frac{e}{m}A < \frac{e}{m}D < \frac{e}{m}B < \frac{e}{m}C$

c) $\frac{e}{m}A = \frac{e}{m}B > \frac{e}{m}D > \frac{e}{m}C$

d) $\frac{e}{m}A = \frac{e}{m}B = \frac{e}{m}C = \frac{e}{m}D$.

4.15 11.5 gm sodium is liberated from fused NaCl by passing of a charge of :

a) 0.5 Faraday
b) 1.0 Faraday
c) 2.0 Faraday
d) 96500 Coloumb.

4.16 According to Bohr's model, the energy E_n of each stationary state is given by the expression :

$E_n = \frac{-1312}{n}$ KJ mol^{-1}, where the term n represents

a) the Rydburg constant

b) the Planck's constant

c) the quantum number of the energy level

d) the frequency of radiation.

4.17 Which set of quantum numbers is possible for an element:

a) $n=1$; $l=1$; $m=0$; $s= -\frac{1}{2}$

b) $n=2$; $l=1$; $m=0$; $s= +\frac{1}{2}$

c) $n=2$; $l=0$; $m= -2$; $s= +\frac{1}{2}$

d) $n=1$; $l=0$; $m=1$; $s= -\frac{1}{2}$

4.18 2s orbital is represented by the quantum number :

a) $n=2$; $l=0$

b) $n=1$; $l=2$

b) $n=2$; $l=2$.

d) $n=2$; $l=2$.

4.19 Which of the following representations show maximum stability :

a) $1s^2$

b) $2p^6$

c) $3d^5$

d) $4f^7$

4.20 Which of the following show isoelectronic pair ?

a) H^-, He^+

b) Na, Mg^{+2}

c) Cl^-, Ne

d) Li, Be^+

(B) **Completion type items**

Complete the following:

4.21 ________ is a natural phenomenon that supports the experimental conclusion that atoms are divisible.

4.22 The nuclear model of the atom was first proposed by ___

4.23 The corpuscular theory of light explained the experimental laws of ___i)___ and ___ii)___ of light, but failed to account for the phenomena of ___iii)___ and ___iv)___ .

4.24 An atom of an element has 26 electrons and has a mass number 56. The nucleus of this atom contains _____ neutro

4.25 If the value of the azimuthal quantum number is 3, the possible values of magnetic quantum numbers are ______.

4.26 For an element with atomic number 19, the 19th electron will occupy ________ orbital.

4.27 For an electronic configuration of $4f^1$, the azimuthal quantum number is __________.

4.28 The electronic configuration of an element with atomic number 21 is ______________ .

4.29 Electrons in a given subshell tend to remain unpaired with parallel spins. This statement is known as __________.

4.30 The energy released when a nucleus is formed from its components viz. neutrons and protons is called the ________ .

4.31 An element with atomic number X and atomic mass Y will have ___i)___ electrons ___ii)___ protons and ___iii)___ neutrons.

4.32 The arrangement of orbitals as per Aufbau Principle is .....3s, 3p, ___i)___ , ___ii)___ , 4p, ___iii)___ , ___iv)___ , ___v)___ 6s.

4.33 The value of Planck's constant is ____________ .

4.34 Einstein regarded light energy to be carried in Packets named ________.

4.35 A radioactive substance emanates ___i)___ , ___ii)___ and γ ___iii)___ .

4.36 An electron in the first shell will have ___i)___ stability and ___ii)___ energy than an electron in the fourth shell.

4.37 The maximum number of electrons that are permitted are ___i)___ in an s orbital, ___ii)___ in a p-orbital and ___iii)___ in the fourth main shell.

4.38 The number of electrons in the hydrogen ion is ______.

4.39 An emission spectrum has electro-magnetic radiation of definite ________ .

4.40 Apart from the spatial distribution given by the orbital, an electron has an additional characteristic called ______.

(C.) True and false type items :

Classify the following statements as true (T) or false (F) :

4.41 When sodium atom ionises to sodium ion, the composition of the nucleus remains unchanged.

4.42 There are five 3d orbitals.

4.43 The quantum number which specifies the energy of an electron is the spin quantum number.

4.44 Albert Einstein was awarded the Nobel prize for his work on photoelectric effect.

4.45 The Pauli Exclusion Principle states that no two electrons in an atom can have the same set of 4 quantum numbers.

4.46 The atomic mass of an atom is always a whole number.

4.47 In an s orbital the electronic distribution is symmetrical in all directions, whereas in p orbitals, the distribution is along the axes.

4.48 The energy required to break up the nucleus into neutrons and protons is called the bond energy.

4.49 Atomic emission spectra is useful in chemical analysis because atoms of different elements emit radition of characteristic set of wavelengths.

4.50 The charge and the mass of the nucleus are entirely due to the protons.

4.51 Flouresence as seen in gas discharge tubes is due to the bombardment of the glass of the tube by the cathode rays. T

4.52 Wavelength of U.V. radiation is longer than that of the I.R. radiation. F

4.53 All natural phenomena due to light can be completely explained by the wave nature of light.

4.54 The gas discharge tube has played a significant role in the discovery of electrons.

4.55 The 1s orbital is spherical, while the 2s orbital is dumb bell shaped. F

4.56 Bohr's theory worked perfectly for the hydrogen atom but it failed to predict spectra of more complicated atoms. T

4.57 Louis de Broglie stated that it is not possible to determine simultaneously the position and the momentum of a body to an arbitrary accuracy.

4.58 "Quantum" of energy refers to a discrete packet of energy.

4.59 Under certain conditions, an electron makes a transition from a state of higher energy to a state of lower energy. The difference in energy is given out in the form of radiation. T

(D.) Matching type items

4.60 Match the items in the List A with the items in List B, by indicating the serial number of the items of List A against that of List B.

	LIST A property		LIST B units
a)	frequency	i)	nanometer
b)	wavelength	ii)	kilojoules
c)	velocity	iii)	meter per second
d)	energy	iv)	kilohertz
		v)	atomic mass unit.

II. SHORT ANSWER TYPE ITEMS

4.61 Applying the "Aufbau Principle" write the electronic configuration of the element with atomic number 21. $1s^2, 2s^2, 2p^6, 3s^2\ 3p^6$ [illegible]

4.62 How did Rutherford's experiment lead to the nuclear model of an atom ?

4.63 What is meant by: S orbital is spherical ?

4.64 Explain the principle underlying photoelectric effect.

4.65 What are the main constituents of an atom ? Explain their characteristics.

4.66 How does the Thomson model of an atom differ from the Rutherford model ?

4.67 Indicate the basic concepts underlying Bohr's model of hydrogen atom.

4.68 Although Rutherfords' nuclear atom had strong similarities to a small scale solar system, but whereas Newtons' laws could explain the solar system, these laws could neither explain the stability of the atom, nor it's, line spectra. Explain why ?

4.69 What led de Broglie to put forward his equation ?

4.70 What do you understand by the term "electronic structure ff atoms ?

4.71 What are the characteristics of radiation from a radioactive substance ?

4.72 What were the reasons for replacing the Bohr's model of atom by the later concepts ?

4.73 What were the assumptions on which Dalton developed his atomic hypothesis ? Which of these postulates seemed to be wrong ? Why ?

4.74 Why is it that the value of e/m as determined in the gas discharge tubes turn out to be a constant, whatever may be the gas in the tube ?

4.75 Why was Newton's theory of "Corpuscles of light" discarded ?

4.76 Bohr's rule relating the energy difference to the frequency radiation has the form $E_2-E_1=h\nu$. Explain this equation.

III LONG ANSWER TYPE ITEMS

4.77 Dalton, J.J. Thomson, Rutherford, Bohr and de Broglie all have contributed to understanding of the structure of an atom. Amongst these scientists who in your view has contributed the most important aspect in the field ? Justify your answer.

4.78 Explain the Aufbau principle in deducing the electronic configuration of elements with atomic numbers ranging from 9 to 22.

4.79 What do you understand by the quantum mechanical model of an atom ? In what way is it superior to the earlier models of the atom ?

IV. NUMERICAL PROBLEMS

4.80 All India Radio Madras transmits its programmes at a wavelength of 420m. Calculate the frequency of the broadcast in kilo hertz. (Given, velocity of light = 3×10^8 ms^{-1}).

4.81 Naturally occuring copper contains 69.09% of ^{63}Cu and 30.91% of ^{65}Cu. Calculate the atomic weight of copper (given atomic mass of ^{65}Cu is 64.93 amu, and that of ^{63}Cu is 62.93 amu).

4.82 Calculate in nm the shortest wavelength in the absorption spectrum of hydrogen (given, Rydberg constant = 109677 cm^{-1}).

4.83 Calculate the frequency of the indigo light in the visible spectrum for a corresponding wavelength of 450 nm. (Given velocity of light is 3×10^{8} ms^{-1}).

4.84 Calculate the wavelength from the Balmer formula, when n = 4. (Given Rydberg constant is 109677 cm^{-1}).

4.85 Calculate the kinetic energy of a photoelectron produced in cesium by 400 nm light. The critical (maximum) wavelength for photoelectric effect in cesuim is 660 mm, (Given Planck's constant is 6.63×10^{-34} Js and velocity of light is 3×10^{8} ms^{-1}).

UNIT - 5

CHEMICAL FAMILIES - PERIODIC PROPERTIES

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice : Write the correct answer:

5.1 Two of the elements for which Mendeleev left gaps in the periodic table and even predicted their properties were :

a) gallium and germanium
b) aluminium and silicon
c) chromium and manganese
d) arsenic and antimony

5.2 Long form of the periodic table is based on

a) Mendeleev's periodic law
b) Newland's law of octaves
c) Lother-Meyer's curves
d) Modern periodic law.

5.3 In the periodic table elements with similar properties occur in the same group because they have the same

a) ionisation energy
b) outer electronic configuration
c) atomic volume
d) number of quantum shells.

5.4 Every period in the periodic table begins with a new

a) principal quantum number
b) azimuthal quantum number
c) spin quantum number
d) magnetic quantum number.

5.5 The man made elements find place among the

a) actinide series
b) lanthanide series
c) alkali metals
d) alkaline earth metals.

5.6 The elements placed outside the main body of the periodic table are

a) the transition elements
b) the inner transition elements
c) the noble gases
d) the representative elements

5.7 The filling of electrons in the third period takes place successively in

a) 2s and 2 p
b) 3s and 3 p
c) 3s, 3 p and 3 d
d) 4s and 4 p

5.8 The electronic configuration that refers to the least reactive group of elements is :

a) $ns^1\ ns^2$
b) $ns^2\ np^4$
c) $ns^2\ np^1$
d) $ns^2\ np^6$

5.9 Which of the following configurations represents the s - block elements ?

a) ns^{1-2}
b) $ns^2\ np^1$
c) $ns^2\ np^6$
d) $ns^2\ np^5$

5.10 Which of the following represents the electronic configuration of the transition elements ?

a) ns^{1-2}
b) $(n-2)\ f^{1-14}\ (n-1)\ d^{0-1}\ ns^2$
c) $nd^{1-10}\ ns^{1-2}$
d) $(n-1)\ d^{1-10}\ ns^{1-2}$

5.11 Which of the following transitions involves the maximum amount of energy ?

a) $M_{(g)} \longrightarrow M^{+}_{(g)}$

b) $M(g) \longrightarrow M^{3+}(g)$

c) $M(g) \longrightarrow M^{2+}(g)$

d) $M(g) \longrightarrow M^{4+}(g)$

5.12 The extremely low chemical reactivity of noble gases is due to their

a) low ionisation energy
b) low electronegativity
c) closed shell structure
d) high electron affinity

5.13 With respect to elements in a particular period, identify the correct statement :

a) Decrease in nuclear charge causes an increase in ionisation energy.
b) Increase in nuclear charge causes an increase in ionisation energy.
c) Decrease in size decreases the ionisation energy.
d) Increase in the number of valence electrons decreases the ionisation energy.

5.14 The elements A and B belong to the same group of the periodic table. The element B has higher atomic number but lower ionisation energy than A. This is because,

- a) B is smaller than A in atomic size
- b) B has larger atomic size than A
- c) B has lower number of valence electrons than A
- d) A has greater nuclear charge than B.

5.15 Identify the incorrect statement. As one goes down a group in the periodic table,

- a) generally, ionisation energy decreases ,
- b) the outer electron is removed farther from the nucleus ,
- c) there is an increasing screening of the nuclear charge by the electrons in the inner shell
- d) generally, electron affinity increases.

5.16 The element named Ekaaluminium was found to be :

- a) germanium
- b) gallium
- c) francium
- d) uranium

(B) Completion type items

Complete the following

5.17 The problem of position of isotopes in the periodic table was avoided by arranging the elements in the ascending order of ________.

5.18 Two different elements may have the same atomic mass but not the same ________.

5.19 When compared to lithium, it is easier to remove the valence electron of potassium, because, potassium has lower ________.

5.20 When an electron is added to a neutral gaseous atom of chlorine and bromine, 349 kJ mole^{-1} and 324 kJ mole^{-1} of energy are released respectively. This shows that chlorine has a lower ________.

5.21 Among halogens the element that has the lowest electron affinity is ________.

5.22 Among alkali metals the element that has the lowest ionisation energy is ________.

5.23 Among the elements Li, Be, B, C, N, O, F and Ne, the element that has the highest electronegativity is ________.

5.24 Generally electron affinity ___i)___ on going down a group, and ___ii)___ on going accross a period.

5.25 Isoelectronic species have the same number of ________.

5.26 Lanthanides and actinides form the ___f___ block of the periodic table.

5.27 Elements belonging to the same group have similar properties since they have similar ________.

5.28 Generally the atomic size along a period gradually decreases due to increase in ________.

5.29 For non metallic elements atomic radius is the radius of the atom bound by _______ covalent bond.

5.30 Since the flourides of Li, Be and B which belong to the 1st, 2nd and 3rd group respectively, have molecular formula LiF, BeF_2 and BF_3, the flouride of carbon should have the formula ________.

5.31 The solubility of alkali metal carbonates __________ as one goes down the group.

5.32 The most common valency of the elements of the first four groups is the same as their ______________.

5.33 In the modern periodic table, elements are arranged according to their increasing order of ____________.

5.34 The electronic configuration of Re^{3+} is $(Xe)\ 4f^{14}\ 5d^{4}$. The number of unpaired electrons in this ion is _____.

(C) True and False type items

Classify the following statements as true (T) and False (F)

5.35 a) Dobereiner developed the law of octaves.

b) Lothar Meyer used physical properties viz. atomic volume, melting point, boiling point to arrive at his table of elements.

c) Mendeleev's periodic law states " that the properties of the elements, depend in a periodic manner on the atomic weight of the elements".

d) Gallium was called Ekasilicon by Mendeleev.

e) Though rational, but Mendeleev's periodic table was an empirical classification of elements.

5.36 a) Atomic number is a more fundamental property than atomic mass.

b) The periodic table classifies elements based on their electronic configuration.

c) The 2nd period ends with Argon with the electronic configuration (..$2s^2$ $2p^6$).

d) The successive filling of 3s 3p orbitals gives rise to the 3rd period with elements from sodium to neon.

e) The first transition series is called the actinide series.

5.37 a) The highest ionisation energy is associated with the alkali metals.

b) High reactivity of elements is reflected in their high ionisation energy.

c) Electron affinity values can be negative also.

d) Atomic radii can be precisely determined by knowing the distance between the atoms in the combined state.

e) The valency of the representative elements is essentially equal to the number of electrons in their outermost orbital.

(D) [illegible]

5.38 Match the items given in list A with relevant answers given the list B by indicating the serial number of item of list A against that of list B.

List A

block in periodic table

a) s block

b) d block

c) f block

d) s & p block

List B

occupied by

i) transition elements

ii) inner transition and actinides

iii) highly electropositive [illegible]

iv) halogens

v) representative elements

vi) noble gases

5.39 **List A**

Hero

a) Winkler

b) Newlands

c) Mendeleev

List B

Associated with [illegible]

i) periodic law

ii) determination of properties of germanium

iii) law [illegible]

iv) atomic volume curve

v) atomic number

5.40

	List A electronic configuration		List B general name of elements
a)	ns^1 configuration	i)	inner transition elements
b)	ns^2 configuration	ii)	transition elements
c)	$(n-1)\ d^{1-10} ns^{1-2}$	iii)	alkali metal
d)	$(n-2)\ f^{1-14} (n-1)\ d^{0-1}\ ns^2$	iv)	alkaline earth metal
		v)	halogens
e)	$ns^2\ np^5$ configuration	vi)	noble gases
		vii)	chalcogens.

5.41

	List A elements		List B electronic configuration
a)	Ne	i)	$\ldots 2s^2$
b)	Be	ii)	$\ldots 2s^2 2p^6$
c)	B	iii)	$\ldots 3s^1$
d)	N	iv)	$\ldots 2s^2 2p^3$ d
e)	Na	v)	$\ldots 2s^2 2p^2$
		vi)	$\ldots 2s^2\ 2p^1$

5.42

	List A group		List B general name of elements
a)	1st group	i)	Noble gases d
b)	16th group	ii)	coinage metals
c)	17th group	iii)	alkali metals a
d)	18th group	iv)	alkaline earth metals
		v)	chalcogens b
		vi)	halogens. c

5.43

List A halides		List B M represents	
a)	M X	i)	Na
b)	$M X_2$	ii)	H
c)	$M X_3$	iii)	Mg
d)	$M X_4$	iv)	[illegible]
		v)	C
		vi)	Ba

5.44

List A element		List B isoelectronic to	
a)	He	i)	F^-
b)	Ar	ii)	S^{2-}
c)	F	iii)	O^-
d)	Ne	iv)	Li^+
e)	Na	v)	H^+

5.45

List A compound		List B Valency of the less electronegative species	
a)	Al_2O_3	i)	+ 6
b)	BaO	ii)	+ 2
c)	N_2O_5	iii)	+ 3
d)	SO_3	iv)	+ 5
		v)	+ 4

II SHORT ANSWER TYPE ITEMS

5.46 What was the basis of the classification of elements in Mendeleev's periodic table?

5.47 Give reasons why the number of elements in the first period is only 2.?

5.48 On the basis of their electronic configuration explain why alkali metals are highly reactive.

5.49 In a period in the periodic table, explain why the ionisation energy of elements increases on going from left to right.

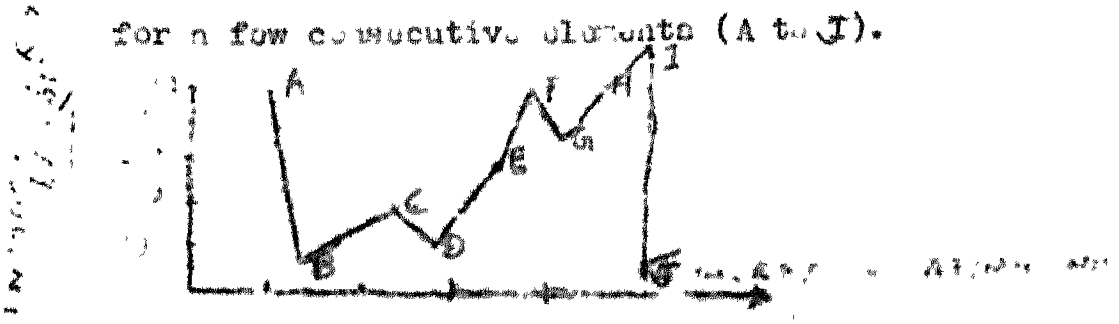
5.50 In a vertical group the atomic radius of an element A is greater than that of element B. Which of these two elements do you think will have higher atomic number?

5.51 Suggest reason for the increase in the first ionisation energy from H to He.

5.52 Give the order in which the melting points of halides of sodium decrease. NaF > NaCl > NaBr > NaI

5.53 Arrange the hydroxides of Mg, Ca, Sr, Ba in order of their decreasing basicity. $Ba(OH)_2$ $Sr(OH)_2$ $Ca(OH)_2$ $Mg(OH)_2$

5.54 Given below is a plot of first ionisation potential for a few consecutive elements (A to J).



Write the letter corresponding to :

a) the most metallic element;

b) the element with the largest atomic radius;

c) the element which forms the most ionic compound when it reacts with J;

d) the element which has a valency shell configuration corresponding to: [illegible]

e) the two elements which are likely to have similar properties.

III LONG ANSWER TYPE ITEMS

5.55 Point out the weaknesses of Mendeleev's period table. How valid is the table in the light of modern discoveries ?

5.56 What is meant by periodic trends in properties of elements ? Answer with suitable examples.

IV NUMERICAL PROBLEMS

5.57 The volume of a sample of solid C containing 1 mol of atom is 5.0 cm^3. While that of a similar sample of N is 14 cm^3, calculate the density of each of these two elements. (atomic weights of C = 12 and N = 14).

5.58 The first ionization energy of M is 367 kJ mol^{-1}. One mole of M atom reacts with 1 mol of X atoms to form 1 mol each of M^+ and X^- ions, absorbing 225 kJ of heat in the process. If all reactants and products are gaseous isolated particles, what is the electron affinity of X ?

5.59 The first ionization energy of Na is 496 kJ mol^{-1}. The electron affinity of Cl is 348 kJ mol^{-1}. One mole of gaseous Na reacts with 1 mol of gaseous Cl atom to form 1 mol each of Na^+ and Cl^-. Does the overall process liberate or/does it absorb energy ? . . ?
What is the magnitude of this energy change ?

UNIT - 6

BONDING AND MOLECULAR STRUCTURE

I OBJECTIVE TYPE ITEMS

(a) Multiple choice : Write the correct answer

6.1 Lewis structure for sodium phosphide is :

a) $\mathrm{Na} : \underset{\underset{\mathrm{Na}}{\cdot\cdot}}{\overset{\cdot\cdot}{\mathrm{P}}} : \mathrm{Na}$

[✓ b)] $(\mathrm{Na}^{+})_{3}\ (:\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{P}}}:^{3-})$

c) $(\mathrm{Na}^{+})_{2}\ (:\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{P}}}:^{3-})$

d) $\mathrm{Na} : \overset{\cdot\cdot}{\mathrm{P}} : \mathrm{Na}.$

6.2 The angle that corresponds to sp^2 hybridisation is :

a) 180°

[✓ b)] 120°

c) 90°

d) 60°

6.3 The molecule which has a trigonal bipyramid geometry is:

a) CH_4

b) C_2H_4

[✓ c)] PCl_5

d) C_2H_2

6.4 The molecule with [illegible] and [illegible] bonds between the two carbon atom is :

a) C_2H_2

b) C_2H_4

c) C_3H_6

d) C_3H_8

6.5 In N_2 molecule, the bonds between the two nitrogen atom is a :

a) single covalent bond

b) double covalent bond

[✓ c)] triple covalent bond

d) coordinate covalent bond

6.6 An atom has six electron pairs around it. The shape of the molecule according to VSEPR model, formed with this atom as the central atom, will be :

a) square planar

b) octahedral

c) tetrahedral

d) trigonal bipyramidal

6.7 An appropriate description of bonding in $CaCl_2$ will be :

a) covalent bonding
b) electrovalent bonding
c) hydrogen bonding
d) coordinate covalent bonding.

6.8 The compound expected to have pyramidal structure is:

a) NF_3
b) PCl_5
c) BF_3
d) AlF_3

6.9 If the electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$, the electrons which take part in bond formation are :

a) $4s^2$
b) $4s^2\ 3d^3$
c) $4s^2\ 3p^6$
d) $4s^2\ 3p^5\ 3d^3$

6.10 Graphite has a sheet structure, where the sheets are held together by :

a) covalent bonds
b) van derwaal's force
c) ionic bond
d) hydrogen bond

6.11 A compound is a non-conductor of electricity, but becomes a good conductor when dissolved in water. This compound is a :

a) covalent solid

b) ionic solid

c) molecular solid

d) metallic solid

6.12 A solid has a giant structure. It is very hard, resists deformation and melts at a very high temperature. The solid could be :

a) an ionic solid

b) a covalent solid

c) a molecular solid

d) a metallic solid

6.13 Hydrogen flouride has comparatively higher boiling point than other hydrides of halogens. This can be explained by assuming that hydrogen fluoride has:

a) covalent bonding

b) electrovalent bonding

c) hydrogen bonding

d) coordinate covalent bonding

6.14 The electronic configuration of 3 elements X, Y, Z is given by :

X : $1s^2\ 2s^2\ 2p^5$;

Y : $1s^2\ 2s^2\ 2p^3$;

Z : $1s^2\ 2s^2\ 3p^6\ 3s^2$;

then,

i) A molecule of X is represented by :

a) X
b) X_2
c) X_3
d) X_4

ii) X – X bond will be :

a) ionic
b) covalent
c) coordinate covalent
d) metallic

iii) X – Y bond will be :

a) ionic
b) covalent
c) coordinate covalent
d) metallic

iv) A molecule of Z is represented as :

a) Z
b) Z_2
c) Z_3
d) Z_4

6.15 The compound where [illegible] applicable is :

a) sodium chloride

b) chlorine molecule

c) phosphorous trichloride

d) hydrogen molecule

6.16 Among the following [illegible]

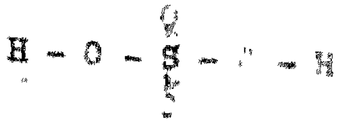
a) metallic bond

b) covalent bond

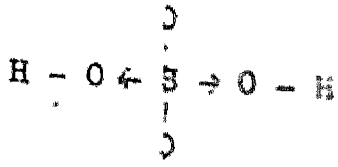
c) hydrogen bond

d) van derwaal's bond

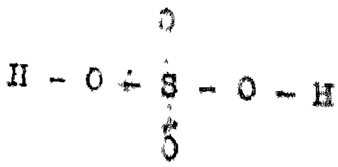
6.17 H_2SO_4 is a good example of [illegible] coordinate bond. The bonding [illegible] be represented as :

a) 

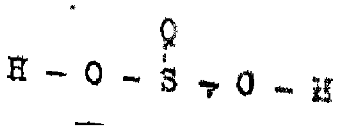
$\mathrm{H-O-}\overset{\overset{O}{\uparrow}}{\underset{\underset{O}{\downarrow}}{S}}\mathrm{-O-H}$

b) 

$\mathrm{H-O\leftarrow}\overset{\overset{O}{|}}{\underset{\underset{O}{|}}{S}}\mathrm{\rightarrow O-H}$

c) 

$\mathrm{H-O\leftarrow}\overset{\overset{O}{|}}{\underset{\underset{O}{\downarrow}}{S}}\mathrm{-O-H}$

d) 

$\mathrm{H-O-}\overset{\overset{O}{\uparrow}}{S}\mathrm{\rightarrow O-H}$

6.18 The compound that does not have a linear structure is :

a) CO_2

b) $BeCl_2$

c) C_2H_2

d) O_3

6.19 Identify the incorrect statement :

a) Resonance structures have no physical reality.

b) Resonance structures exist in imagination only.

c) Resonance structures are used because behaviour of many molecules cannot be represented by a single Lewis structure.

d) Resonance structure and canonical form are two different concepts.

6.20 Identify the incorrect statement :

a) Ionic solids generally have high melting points.

b) In the molten state the regular arrangement of a crystal is destroyed.

c) Ionic solids conduct electricity.

d) Ionic solids dissolve easily in polar solvents.

6.21 Identify the incorrect statement :

a) Since parallel orientation of the p orbitals is necessary for a proper sideways overlap, all atoms of a molecule such as C_2H_4 must be in the same plane to ensure that the p orbitals are parallel.

b) Rotation of one CH_2 fragment with respect to the other will interfere with sideways overlap of the p orbitals and therefore such rotation is prohibited.

c) A disubstituted ethylene such as $C_2H_2Cl_2$ can exist in 2 forms because of the absence of rotation of carbon atoms around the C = C bond.

d) Free rotation around a π bond is not permissible.

(B) Completion type items

Complete the following:

6.22 a) In the formation of N_2 molecule, ________ electron pairs are shared between the two nitrogen atoms.

b) The critical distance between the two atoms at which the force of attraction is equal to the force of repulsion is called the ________.

c) All the 4 Si - Cl bonds in $SiCl_4$ are ___i)___ and are directed towards four corner of a ___ii)___.

d) The hybridization in BF_3 involves ___i)___ and ___ii)___ orbitals.

e) $C_2H_2Cl_2$ exists in cis and trans forms because of the absence of ______ around C = C bond.

6.23 a) π bond is formed by ________ overlap of atomic orbitals.

b) In π bond, electron density is concentrated ___i)___ and ___ii)___ the plane of the bonding atom.

c) The abnormal melting point and boiling points of NH_3 and H_2O are due to the formation of __________ bond.

d) In a compound AB, if A attracts the shared pair of electrons, then A is more _________ than B.

e) O_2 molecule is __________ in nature, due to the presence of two unpaired electrons.

6.24 a) Compounds are represented by their empirical formula, or their molecular formula, or their structural formula.

- i) The formula that gives the relative number of different kinds of atoms is called the .
- ii) That which gives the relative arrangement of atoms is called the ________ .
- iii) That which gives the actual number of different atoms is called the ________.

b) Whenever two atoms are held by a pair of shared electrons, a ______ bond is said to exist between them.

c) The valence electrons that are not involved in bonding (ie sharing) are called the i)______ pairs of ii)______ pairs or iii)______ pairs.

d) The extended form of the VSEPR theory is ______

e) The critical distance between atoms which correspond to the minimum energy and maximum stability of a bond is called the ______ length.

6.25 a) A covalent bond where only one of the atoms contribut both the electrons is said to be a ______ covalent bond.

b) In an ionic bond, it is possible to find out which atom will have a greater share of the electron pair by comparing the ______ of the two atoms.

c) The concept of electronegativity was first introduced by the scientist ______.

d) Electronegativity is a measure of the attraction that an atom has for a ______ pair of electrons in a molecule.

e) ______ is the most electronegative elem

(C) True and false type items

6.26 **Classify the following statements as True(T) or False(F):**

a) HF is a non polar molecule.

b) CO_2 is a linear molecule.

c) BCl_3 is an electron deficient compound.

d) In the "condensed state", one observes ionic and covalent substances and substances characterised by the so called metallic bond and vander waals bond.

e) Hydrogen bonds are stronger than covalent bonds.

6.27 a) CH_4 has a zero dipole moment

b) An ionic bond is an extreme case of a polar covalent bond.

c) Bonding in C_2H_6 involves a sp^2 hybridization

d) The structure of O_3 can best be represented as a resonance hybrid.

e) Ionic substances conduct electricity in the molten state because the ions are free to move.

6.28 a) A covalent bond can also result if only one of the atoms contributes both the electrons.

b) An ionic bond is formed due to an electrostatic force between oppositely charged ions.

c) Covalent and ionic bonds are the only possibilities in isolated molecules. [illegible]

d) A hydrogen bond is weaker than vander Waal's interaction.

e) Electrons are charge carriers in metals whereas positive and negative ions are charge carriers in ionic liquids.

(D) M[illegible]

6.29 Match the items given in list A with relevant answer given in the list B by indicating the serial number of item of list A against that of list B.

List A Bonding in solid state		List B Examples	
a)	ionic solid	i)	solidified hydrogen g b
b)	molecular solid	ii)	rhombic sulphur
c)	covalent solid	iii)	copper
d)	metallic solid	iv)	potassium chloride (a
		v)	silicon carbide

6.30

List A Geometry		List B (bond angles)	
a)	trigonal planar	i)	90° c
b)	tetrahedral	ii)	180° d
c)	octahedral	iii)	120° a.
d)	linear	iv)	109.5 b
		v)	110°

6.31

	List A Compound		List B (Shape of the molecule)
a)	SF_6	i)	tetrahedral
b)	BF_3	ii)	linear
c)	CCl_4	iii)	trigonal bipyramid
d)	[illegible]	iv)	trigonal planar
e)	PCl_5	v)	octahedral
		vi)	[illegible]

II **SHORT ANSWER TYPE ITEMS**

6.32 Give Lewis electron dot structures for the following compounds :

a) C_2H_4

b) [illegible]

c) O_3

6.33 Sodium chloride [illegible] on treating it with silver nitrate, [illegible] does not respond to this test. Give reason.

6.34 The H-S-H bond angle in H_2S is 92.2°, whereas the H-O-H bond angle in H_2O is 104.5°. Account for this difference.

6.35 Explain the formation of ethane molecule with the help of an orbital diagram.

6.36 There are 4 elements A, B, C, D having atomic numbers 11, [illegible] respectively. Write the empirical formula of the [illegible] containing

a) A and C,

b) B and C,

c) D only and

d) C only

6.37 Why is it necessary to [illegible] a resonance structure for ozone?

6.38 The melting points of PH_3, AsH_3, SbH_3 increase with an increase in the molecular mass. Account for this observation.

6.39 In the formation of AX_3, A loses three electrons. Give the electron [illegible] of AX_3.

6.40 AB_2 and CD_2 are two compounds, out of which AB_2 has a dipole moment whereas CD_2 has [illegible] dipole moment. Which of these two compounds will be linear? What do you infer about the electronegativity of a) A and B and b) C and D?

6.41 BCl_3 consists of polar bonds but it is not a polar molecule. Explain :

6.42 How do you explain for lusture in metals ?

6.43 Taking into consideration that the electronic configuration of carbon is $1s^2$ $2s^2$ $2p^2$, how do you explain the predominance of tetravalency for carbon ?

6.44 Draw the resonance structure for sulphur dioxide.

6.45 Suppose a hydrogen molecule is formed between an atom of a lighter isotope ($^{1}_{1}H$ and another of a heavier isotope ($^{3}_{1}H$). What do you expect the polarity of this bond to be ?

6.46 Recognizing that chlorine is more electronegative than iodine, which end of the compound ClI will be positive ? Explain.

6.47 Although very useful in a large number of cases, the octet rule has many exceptions. Give three evidences to support this statement.

6.48 Why are there H_2 molecules, but not He_2 molecules ? Explain.

6.49 What do you expect will happen if you pour liquid oxygen (which consists of O_2 molecules) between the pole pieces of a magnet ? Will you get the same result if you repeat this experiment replacing liquid oxygen by liquid nitrogen ? Explain.

6.50 The electronic configuration of carbon being $1s^2\ 2s^2\ 2p^2$, one would expect carbon to form a divalent compound. However, a majority of carbon compounds are found to be tetravalent. Explain.

6.51 Classify the types of bonds which would be formed as a result of each of the following atomic overlaps

a) s and s
b) s and p
c) p and p (side to side)
d) p and p (end to end).

III LONG ANSWER TYPE ITEMS

6.52 What is meant by polar molecules ? Give examples. What are the factors upon which the polarity of a bond depends ? Why is the bond angle in $H - \underset{H}{N} - H$ 107.3° ?

6.53 In SiH_4, PH_3 and H_2S the bond angle changes from 109.47° to 93.8 to 92.2°. How would the VSEPR theory account for this trend ? Why are the bond angles in NH_3 and H_2O greater than the corresponding values in PH_3 and H_2S ?

6.54 How will you account for the following :

a) NH_3 is soluble in water.

b) Helium does not form He_2 molecules.

c) NaCl has a higher melting point than HCl.

6.55 Discuss the model that is generally accepted to explain the stability of metals.

6.56 What makes a hydrogen molecule more stable than two hydrogen atoms ? How can you explain the statement: a set of two hydrogen atoms has lowest energy at a critical distance ?

IV NUMERICAL PROBLEMS

6.57 The internuclear separation in sodium chloride molecule is 0.283 nm. Assuming complete transfer of electrons from sodium to chlorine atom,) calculate the dipole moment of sodium chloride; b) what will be the direction of the dipole moment ? (Given, charge of electron is 1.602×10^{-19} C).

6.58 The dipole moment of LiH is 1.964×10^{-29} Cm, and the inter ionic distance between Li and H in this molecule is 1.596×10^{-10} m. What is the % ionic character in LiH ? (Charge of electron is 1.602×10^{-19} C).

UNIT 7

CARBOND AND ITS COMPOUNDS

I. OBJECTIVE TYPE ITEMS

(A) Multiple choice type: Write the correct answer:

7.1 In nature pure elemental carbon is found as :

[✓ a)] diamond

b) lignite

c) coke

d) carbon black

7.2 Which of the following properties is not applicable to diamond?

a) Diamond is a very hard substance and is employed where hardness is desired.

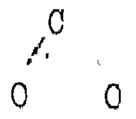
[✓ b)] Diamond is transparent and a good conductor of electricity.

c) Diamond is an allotrope of carbon.

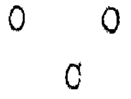
d) In diamond carbon atoms exist in an sp^3 hybridised manner.

7.3 The structure of CO_2 molecule is best represented as:

a)



b)



[✓ c)] $O = C = O$

d) none of the above, (a, b, c)

7.4 Which of the following is not a characteristic propety of

a) It is a colourless gas, heavier than air.

b) It is slightly soluble in water at ordinary temperature and pressure.

[✓ c)] It is poisonous.

d) It does not support life in animals and humans.

7.5 Carbon combines with more electropositive elements than its when heated to high temperatures to form:

a) carbides

b) carbonates

c) cyaindes

d) bicarbonates

7.6 Carbon-carbon triple bond is present in :

a) alkanes

b) alkenes

[✓ c)] alkynes

d) arenes

7.7 Which of the following forms a homologous series?

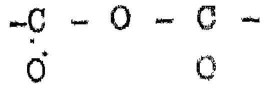
a) C_2H_4, C_2H_2, C_2H_6, C_2H_5

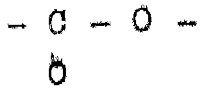
[✓ b)] C_2H_2, C_3H_4, C_4H_6, C_5H_8

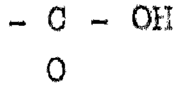
c) C_6H_6, C_7H_{16}, C_8H_{10}, C_9H_{12}

d) CH_4, C_2H_6, C_3H_8, C_4H_6.

7.8 The functional group of an acid anhydride is:

[✓ a)]

$-\underset{O}{C}-O-\underset{O}{C}-$

b)

$-\underset{O}{C}-O-$

c)

$-\underset{O}{C}-OH$

d) $-C-O-C-$

7.9 Compounds with same molecular formula but different arrangements of atoms are known as:

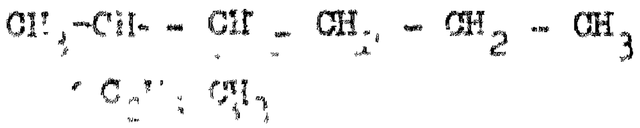
[✓ a)] isomers

b) allotropes

c) homologues

d) isobars

7.10 The IUPAC name of

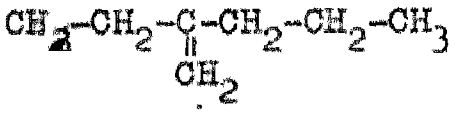

$CH_3-\underset{C_2H_5}{CH}-\underset{CH_3}{CH}-CH_2-CH_2-CH_3$

a) 2-ethyl - 3-methylhexane

b) 5-ethyl - 4-methylhexane

c) 4,5-dimethylheptane

[✓ d)] 3,4-dimethylheptane

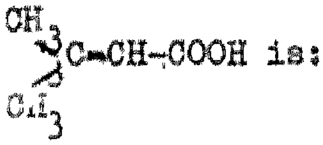

7.11 IUPAC name of the compound: $CH_3-CH_2-\underset{\underset{CH_2}{\|}}{C}-CH_2-CH_2-CH_3$ is:

a) 2-propylbutene - 1

b) 4-ethyl-pent-4-ene

[✓ c)] 2-ethyl-pent-1-ene

d) heptene - 3.

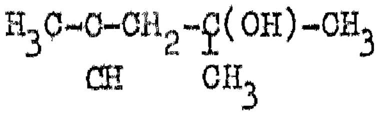
7.12 The IUPAC name of the compound  $^{CH_3}_{CH_3}\!\!>C=CH-COOH$ is:

a) 1-carboxy - 2,2-dimethylethene

b) 2-methyl-but-2ene - 3-oic acid

c) 3-methyl - 2-butenoic acid

d) 2-methylbutenoic acid

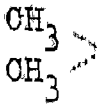
7.13 The IUPAC name of the compound  $H_3C-\underset{CH}{C}-CH_2-\underset{CH_3}{C}(OH)-CH_3$ is:

a) 1,1 - dimethyl - 1,3 butanediol

b) 2 - methyl - 2,4-pentanediol

c) 4-methyl - 2,4-pentanediol

d) 1,3,3 - trimethyl - 1,3 - propanediol

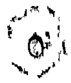
7.14 IUPAC name of the compound  $^{CH_3}_{CH_3}\!\!>OH-OH$ is:

a) isopropyl alcohol

b) 2 - methyl ethanol

c) 1 - methyl ethanol

d) 2 - propanol

7.15 The IUPAC name of the compound  - $COOC_2H_5$ is:

a) ethyl benzoate

b) phenyl ethanoate

c) propanoyl benezene

d) phenyl propanoate

7.16 Producer gas is a mixture of:

a) carbon monoxide and hydrogen

[✓ b)] carbon monoxide and nitrogen

c) normal butane and isobutane

d) methane and ethane

7.17 Unique property of carbon monoxide is that:

a) on combination with water, it gives carbonic acid;

[✓ b)] it reacts with haemoglobin in red blood cells;

c) it is a powerful oxidising agent;

d) it is used to prepare aerated drinks.

7.18 Which of the following statements is not applicable to members of a homologous series?

a) They can be represented by a general formula.

b) There is a regular gradation in their physical properties

c) Most of the members of the series can be prepared by similar methods.

[✓ d)] Two consecutive members differ by a common difference of $-CH_3$ units.

B. Completion type items

Complete the following:

7.19 The property of carbon atom bonding to itself is known as Catenation.

7.20 Organic compounds with same molecular formula but different structural formula are called isomers.

7.21 In graphite the hybridisation of carbon is ____.

7.22 Solid carbon dioxide is known as ____.

7.23 Carbon black is used to ____ rubber for tyre manufactu

7.24 Graphite is used as a ____ [illegible].

7.25 Silicon carbide is commercially known as ____.

7.26 The IUPAC name of HCHO is ____.

7.27 In the IUPAC system the suffix in the name of organic compounds indicates the nature of the ____.

7.28 CO_2 when passed in lime water forms [illegible] and limewater turns milky.

7.29 Bicarbonates of calcium and magnesium are responsible for the temporary hardness of water.

7.30 The phenomenon of existence of different forms of an element is called [illegible].

7.31 Calcium carbide on reaction with water produces [illegible].

7.32 In the reactions Fe_2O_3+CO [illegible] carbon monoxide is acting as a reducing agent.

7.33 Another form of graphite is ____.

7.34 The expanded version of IUPAC is ____.

7.35 CF_2Cl_2 is used as a ____.

7.36 The first organic compound to be synthesised was ____ from ____.

7.37 In aqueous solution both carbonates and bicarbonates are ____ i) ____ due to ____ ii) ____.

7.38 TNT stands for ____ and is used as an explosive.

7.39 LPG stands for Liquefied petroleum gas.

7.40 Living organisms obtain energy from ____ and ____

7.41 Two important reason for the abundance of organic compounds are ________ and ________.

7.42 One of the gaseous products in automobile exhaust which leads to environmental hazards is CO ________.

7.43 Water gas is obtained by passing ____ i) ____ over hot ____ ii) ____.

7.44 Soda water is a solution of ____ i) ____ in water under ____ ii) ____.

7.45 Silicon carbide and ________ carbide are used in cutting and drilling tools.

7.46 Alkenes, alkynes and arenes are unsaturated hydrocarbons

7.47 Important sources of arenes are coal and petroleum.

7.48 The main constituent of vinegar is ethanoic acid.

7.49 Freon or dichlorodifluoromethane is used in ________.

7.50 The constituent of moth balls is ________.

C) True false type items

Classify the following statements as true(T) or false (F).

7.51 The lubricating property of graphite is associated with its sheet structure.

7.52 There are only two allotropic forms of carbon.

7.53 Carbon monoxide is used as a reducing agent in metallurgy.

7.54 The carbon atoms in diamond are sp^2 hybridised.

7.55 The free electrons in graphite are responsible for graphite being used as electrodes in dry cells.

7.56 Tert - butyl alcohol according to IUPAC system is called 2-methyl propanol 2.

7.57 Carbon dioxide dissolves in water to produce carbonic acid

7.58 Ethylbutanoate is the IUPAC name of $CH_3COO\ C_2H_5$.

7.59 The IUPAC name of $(CH_3CH_2CH_2CO)_2O$ is butanoic anhydrid

7.60 The IUPAC name of C_6H_5COCl is chlorobenzene .

7.61 COOH is called 3-chlorobenzoic acid according to the IUPAC system.

7.62 The molecular formula of aminobenzene is $C_6H_5CONH_2$

7.63 The compound Cl is called chlorocyclohexane

7.64 TheIUPAC name of the compound

is nitrocyclohexatriene.

7.65 Carbon black occursin nature.

D) Matching type items

7.66 Match the items given in list A with the relevant answers given in list B by indicating the serial number of item of list A against that of list B.

List B Compound	List B Use
i) SiC	a) preparation of C_2H_2
ii) CF_2Cl_2	b) preparation of CH_4
iii) CCl_4	c) abrasive
iv) CaC_2	d) refrigerant
	e) common solvent

7.67

List A	List B
functional group	formula
i) alkanol	a) $(CH_3)_2$ CH $COOCH_3$ II
ii) alkyl alkanoate	b) CH_3CH_2COOH
iii) alkanal	c) CH_3CH_2 CH_2OH
iv) alkanone	d) CH_3CO CH_3 IV
	e) CH_3 CH_2 CHO I

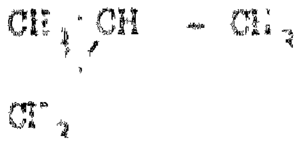
7.68

List A	List B
functional group	structure
i) ethers	a) ROR I
ii) alkenes	b) $>C = C<$ II
iii) alkanals	c) CHO III
iv) acetamide	d) COOR
	e) $CONH_2$ IV

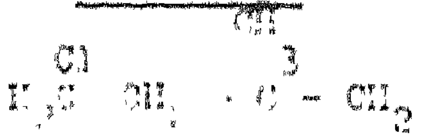
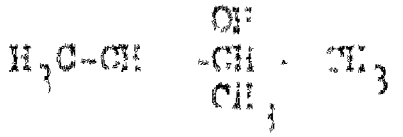
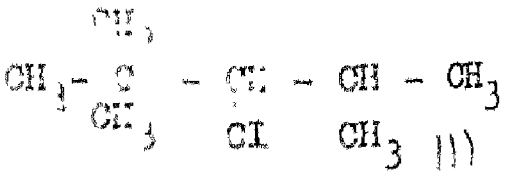
7.70

List A	List B
structure	functional group
i) C_nH_{2n+1} CHO	a) CH_3 CH_2 Cl IV
ii) C_nH_{2n+1} OH	b) CH_3 CH_2 CH_2 OH II
iii) C_nH_{2n+1} COOH	c) CH_3 CH_2 O. CH_3
iv) C_nH_{2n+1} X	d) CH_3 CH_2 CHO I
	e) CH_3 CH_2 COOH III

7.71

List A	List B
general formula	hydrocarbon
i) C_nH_{2n-2}	a) C_6H_6
ii) C_nH_{2n}	b) $CH_3CH = CH_2$
iii) C_nH_{2n+2}	c)  $\underset{CH_3}{CH_3 - CH} - CH_3$
iv) $C_nH_{2n} - 6$	d) $CH_3 C \equiv CH$
	e) $CH_3 - HC - O$

7.72

List A	List B
IUPAC names	Structures
i) 2-methylbutanol-2	a)  $\overset{Cl}{H_3C}\ CH_2 - \overset{CH_3}{C} - CH_2$ ii
ii) 4-chlore -2-methyl- but	b)  $H_3C-CH_2\ \overset{OH}{\underset{CH_3}{-CH}} - CH_3$ i
iii) 2 2 4-trimethyl-3 chloropentane	c) $CH_{3}-C\ C-CH_{2}CH_{3}$
	d) $CH_3 - CH_2 - CH_2 - CH_2OH$
	e)  $CH_3-\overset{CH_3}{\underset{CH_3}{C}} - \underset{Cl}{CH} - \underset{CH_3}{CH} - CH_3$ iii)

II. SHORT ANSWER TYPE ITEMS

7.73 Justify the statement that carbon has a tendency to form large number of compounds.

7.74 Explain the structural features which are responsible for the different physical properties of diamond and graphite.

7.75 Give reasons for graphite being a good conductor of electricity.

7.76 Which structural feature of graphite is responsible for its being used as a lubricating agent ?

7.77 Why is solid carbon dioxide called dry ice ?

7.78 Why does carbon monoxide behave as a poisonous gas ?

7.79 What is meant by the term alkyl group ? Write the possible isomers of C_4H_9.

7.80 Name one compound each of the following functional groups. Write their formula and state some of their uses.

a) $-CHO$

b) $-COOH$

c) $-OH$

d) $-C=C$

7.81 Which of the following reactions do you think can help maintain a check on the increase of CO_2 in nature ?

a) $CaCO_3 \rightarrow CaO + CO_2$.

b) $CH_4+2O_2 \rightarrow CO_2+2H_2O$.

c) $6CO_2 + 6H_2O \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6+6O_2$.

d) $Ca(OH)_2+CO_2 \rightarrow CaCo_3 + H_2O$.

7.82 Name a few common organic compounds and give their use. Group the compounds you have chosen according to their functional groups.

7.83 A metallic oxide (A) on being strongly heated with carbon form a compound (B), B on treatment with water gives a gaseous unsaturated hydrocarbon (C) which is used in welding, Identify A,B,C and write balanced equations for the reactions involved.

III. LONG ANSWER TYPE ITEMS

7.84 What is meant by the term allotropy ? What are the different forms of carbon ? Discuss their properties and uses.

7.85 What is the simplest method of producing carbon monoxide ? Discuss the various methods of preparation of carbon dioxide. Write balanced chemical equations to show that carbon monoxide is a) an unsaturated compound b) a reducing agent.

7.86 Explain the use of organic compounds in the field of i) agriculture ii) medicine, iii) industry.

7.87 About 90% of all compounds are organic compounds. Why is it so ? Discuss briefly the important role that organic compounds play in our daily lives.

7.88 Discuss with appropriate example, IUPAC system of nomenclature of organic compounds.

7.89 What are the major differences between organic and inorganic compounds?

7.90 Give some of the uses of a) alcohols, b) amines, c) acids.

UNIT . 8

ENERGETICS

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice Type : Write the correct answer :

8.1 Which of the following is a nonrenewable source of energy ?

a) biomass
b) solar
c) nuclear fission
d) wind

8.2 Which of the following does not cause environmental pollution ?

a) combustion of fossil fuels
b) photosynthesis in plants
c) non biodegradable waste
d) pesticide residue

8.3 Which of the following is an endothermic reaction ?

a) $2H_2 + O_2 \longrightarrow 2H_2O \; ; \; \Delta H = q$ kJ
b) $N_2 + O_2 \longrightarrow 2NO - Y$ KJ
c) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O \; ; \; \Delta H = -X$ kJ
d) $NaOH + HCl \longrightarrow NaCl + H_2O + Z$ kJ

8.4 The synthesis of ammonia by the Haber's process is represented by the equation :

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)} \quad ; \Delta H = -92 \text{ kJ}$$

What is the enthalpy of formation of ammonia per mole?

a) + 92 kJ

b) - 92 kJ

[✓ c)] - 46 kJ

d) + 46 kJ

8.5 The heat of neutralisation of sulphuric acid and potassium hydroxide is + 57.1 kJ. Therefore the value of ΔH for the reaction :

$$H_2SO_4 + 2KOH \longrightarrow K_2SO_4 + 2H_2O$$

is :

a) -57.1 kJ

b) -28.55 kJ

c) -114.2 kJ

d) + 114.2 kJ

8.6 Identify the incorrect statement :

a) Δ G is zero for a reversible reaction,

[✓ b)] Δ G is positive for a spontaneous reaction,

c) Δ G is negative for a spontaneous reaction.

d) Δ G is positive for a non-spontaneous reaction.

8.7 An exothermic reaction is one in which :

a) the reactants have less energy than the products

b) the reactants have more energy than the products

c) the products have the same energy as the reactants.

d) the reactants and products are at the same temperature.;

8.8 LPG cooking gas consists mainly of :

a) methane and ethane

b) n-butane and isobutane

c) isobutane and hydrogen

d) methane and hydrogen.

8.9 The ΔH values of the following three reactions are given as :

$$C_{graphite} + O_{2(g)} \text{------} CO_{2(g)} \; ; \quad \Delta H_1 = -X \text{ kJ}$$

$$C_{graphite} + \tfrac{1}{2} O_{2(g)} \text{----} CO_{2(g)} ; \quad \Delta H_2 = -Y \text{ kJ}$$

$$CO_{(g)} + \tfrac{1}{2} O_{2(g)} \text{------} CO_{2(g)} \; ; \quad \Delta H_3 = -Z \text{ kJ}$$

Identify the equation that gives the correct relation between the ΔH values of the above reactions.

a) $\Delta H_1 = \Delta H_2 + \Delta H_3$.

b) $\Delta H_1 = \Delta H_2 - H_3$

c) $\Delta H_3 - H_2 = \Delta H_1$

d) $\Delta H_1 + \Delta H_2 + H_3 = 0$

8.10 Which fo thh following is a non spontaneous process ?

a) dissolution of salt in water

b) expansion of a gas into vacuum

c) passage of a gas from a low pressure to high pressure

d) melting of ice

8.11 Any chemical reaction involves :

a) Rearrangement of atoms

b) collision between molecules

c) making and breaking of bonds

[✓ d)] Any or all the features stated in (a,b,c) above.

8.12 While investigating a reaction, the "system" is taken to be :

a) the reactants only

b) the products only

[✓ c)] the reactants and products i.e. the reaction mixture

d) the reaction vessel

8.13 A cup filled with water, and uncovered but placed in a very large cupboard is an example of

a) open system
b) closed system
c) isolated system
d) insulated system

8.14 A stoppered thermosflask completely full of hot coffee is an example of :

a) an open system
b) a closed system
[✓ c)] an isolated system
d) none of the above systems(a,b,c) stated above.

8.15 Hydroelectric power station in India is situated at

a) Narora
[✓ b)] Nangal
c) Kota
d) Kalpakkam

8.16 In determining heat of combustion it is essential to provide

a) oxygen at low pressure
b) one mole oxygen
[✓ c)] Excess oxygen at a good pressure
d) oxygen diluted by an inert gas.

8.17 The condition of a spontaneous reaction is :

- a) ΔH is -ve
- b) ΔS is +ve
- c) ΔH is +ve
- d) ΔG is -ve

8.18 When chemical reactions are carried out in open containers it is considered that :

- a) pressure remains constant
- b) volume remains constant
- c) pressure and volume both remain constant
- d) pressure and volume both change.

(B) Completion type items

Complete the following :

8.19 The energy stored in a compound is called its _________.

8.20 The primary source of energy of the universe is the ____.

8.21 Fossil fuels are termed ____________ source of energy.

8.22 Fossil fuels contain compounds of __i)__ and _ii)__ as impurities.

8.23 Luminous yellow flame indicates insufficient supply of __i)__ and hence __ii)__ combustion. This leads to release of poisonous __iii)__ gas.

8.24 For a chemical reaction, G = 0 is the condition for ____________

8.25 Among ice, water and steam, the one which has maximum entropy is ______________.

8.26 For a spontaneous reactions, G has a __________ value.

8.27 Photosynthesis is a chemical change where energy is provided by the ____________.

8.28 The net reaction involved in the neutralisation of 1 mole of HCl by 1 mole of NaOH is ____i)________
This is called a ____ii)_____ reaction.

8.29 In an exothermic reaction heat is ____i)____, and the value of H is ____ii)____.

8.30 Heat of combustion is the ____i)_____ change when one ____ii)____ of a substance is completely burnt in excess ____iii)_____.

8.31 A reaction is __________ when the enthalpy change is positive.

8.32 Heat of neutralisation is the heat evolved when one ____i)____ of an acid is completely neutralised by one ____ii)____ of a base.

8.32 Hot gases, and hot steam that rush out of the earth's interior in the form of geysers, hot springs etc. constitute the __________ source of energy.

8.34 An ________ system is that in which energy and mass are freely exchanged with the surrounding.

8.35 In an __i)__ system energy cannot be exchanged between the system and the __ii)______.

8.36 Work is done ___i)___ the system when heat is absorbed by the system from the ___ii)____.

8.37 The nuclear stations at Maharashtra and Tamil Nadu are located at ___i)_____ and ____ii)______ respectively.

8.38 Sublimation is an ___i)____ reaction and the sign of H is ___ii)___.

8.39 Energy transfer because of the difference in temperature is referred to as ___i)____ and that due to difference in pressure is one type of ____ii)_____.

8.40 Batteries are examples of ___i)___ energy obtained from chemical reaction ; while Diwali crackers are examples of ___ii)___ and ____iii)____ energy obtained from chemical reaction.

(C) True and False type Items

Classify the following statements as True(T) or False(F) :

8.41 For a reaction

$$A \rightleftharpoons B$$

at equilibrium $\Delta H = T\Delta S$

8.42 In an endothermic reaction heat is evolved.

8.43 Energy change that accompanies a chemical reaction is always expressed in the form of evolution and absorption of heat.

8.44 The SI Unit of energy is Joules.

8.45 Wind is a renewable source of energy.

8.46 Thermochemical calculations are based on Hess's law.

8.47 Incomplete combustion of fuel leads to the release of carbon dioxide.

8.48 $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$; $\Delta H = +180.5$ kJ

is an exothermic reaction.

8.49 $\Delta H = H_{reactants} - H_{product}$.

8.50 $C + O_2$ —— CO_2

is an example of a thermochemical equation.

8.51 Burning of carbohydrates in our body is an endothermic reaction.

8.52 In evaporation of water, ΔH is positive.

8.53 A cloud bursting into a rainfall is a process involving increase of entropy.

8.54 Stars in general are the ultimate source of all our energy.

8.55 When hydrogen atoms combine to form hydrogen molecule, there is a release of energy.

8.56 A non-luminous flame in the burner of cooking gas, is due to incomplete combustion.

8.57 ΔE of a reaction can be conveniently determined at constant temperature and constant pressure.

8.58 Efficiency of engines can be 100% at the maximum level.

8.59 The heat of neutralisation of strong acids and strong bases, is independent of the acid and base.

8.60 Cooking gas contains mainly butane.

(D) Matching type items

8.61 Match the items given in list A with relevant answers given in the list B, by indicating the correct number of items of list A against that of list B.

	LIST A		LIST B
i)	solar energy	a)	cause soil pollution iv
ii)	carbon monoxide	b)	causes climatic changes ✓ii
iii)	sulphur dioxide	c)	cause water pollution ✓
iv)	Pesticide residues	d)	cause genetic disorders ✓i
v)	industrial effluents	e)	is a renewable source of energy

	LIST A		LIST B
vi)	radioactive wastes	f)	causes acid rain
vii)	carbon dioxide	g)	causes death on inhalation
		h)	is a nonrenewable source of energy.

8.62

	LIST A reactions		LIST B energy change in the form of
i)	$2C + 3H_2 \longrightarrow C_2H_6(g)$; $\Delta H = -84.67$ kJ graphite	a)	heat of fusion
ii)	$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$; $\Delta H = -891$ kJ	b)	bond energy
iii)	$C(s) + 4H(g) \longrightarrow CH_4(g)$; $\Delta H = -1664$ kJ	c)	heat of neutralisation
iv)	$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq)$; $\Delta H = -57.1$ kJ	d)	heat of formation
v)	$H_2O(s) \longrightarrow H_2O(l)$; $\Delta H = 6.01$ kJ	e)	heat of combustion

	LIST A		LIST B
vi)	$H_2O(l) \longrightarrow H_2O(g)$; $\Delta H = 44.18$ kJ	f)	heat of vaporisation
		g)	heat of sublimation
		h)	heat of dissociation.

II SHORT ANSWER TYPE ITEMS

8.63 What is acid rain ?

8.64 Explain why the heat of neutralisation of a strong acid and a strong base remains constant irrespective of the nature of the strong acid or the strong base.

8.65 Classify the following into renewable and non-renewable sources of energy. Give reasons for your answer.

i)	biomass	ii)	wind
ii)	nuclear fission	iv)	nuclear fusion

8.66 How does accumulation of carbon dioxide in the atmosphere cause climatic changes ?

8.67 Explain how the direction of a spontaneous change is decided based on free energy changes.

8.68 List four pollutants resulting from combustion of fuels and the health hazards caused by them.

8.69 Cite an example to show that the total heat change in a chemical reaction is the same whether the reaction occurs in one or more steps.

8.70 Explain the basic principles underlying the working of a hydroelectric power station.

8.71 Specify the type of power station existing in the following places. [illegible] [illegible].

i) Kalpakkam ii) Tarapur

ii) Nangal iv) Shivasamudram.

8.72 How would you calculate the bond energy of C-H bond in methane ?

8.73 Distinguish the terms "system" and "surroundings" .

8.74 Can the internal energy of a substance vary ? If so, when ? If not, why not ?

8.75 In energetic, why is the property enthalpy preferred to internal energy ?

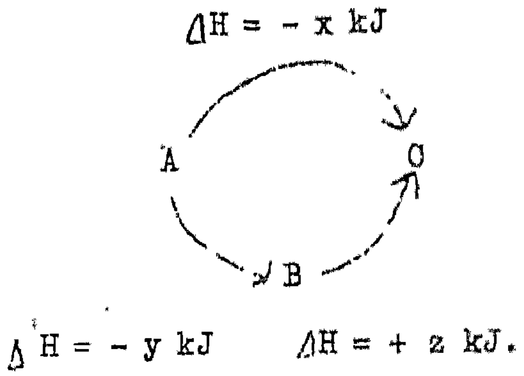
8.76 With reference to the reaction $C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta H = x$ kJ define

i) heat of reaction

ii) heat of formation

iii) heat of combustion

8.77 State and explain Hess's law with reference to the following example



8.78 Why is heat of neutralization of strong acids with strong bases independent of the acid and the base ?

8.79 Why does the entropy of a gas increase when it is released from a closed cylinder to an open space ?

8.80 What are fuels ? How are they classified ?

8.81 What do you understand by the term environmental pollution ? Give some sources of environmental pollution.

8.82 What is meant by 'renewable source of energy' ?

8.83 Can you visualize a situation when chemical reaction occurs due to the absorption of energy from the surroundings ? Give an example to support your answer.

8.84 Explain in brief why energy changes accompany chemical reactions.

8.85 Predict the sign of ΔS for each of the following reactions. Support your prediction logically.

a) $C_2H_4\ (g) + 2O_2\ (g) \longrightarrow 2CO\ (g) + 2H_2O\ (g)$

b) $CO(g) + 2H_2\ (g) \longrightarrow CH_3OH\ (g)$

c) $Hg_2Cl_2\ (s) \longrightarrow 2Hg\ (l) + Cl_2\ (g)$

d) $Hg\ (s) + H_2O\ (l) \longrightarrow HgO\ (s) + H_2\ (g)$

e) $Fe_2O_3\ (s) + CO\ (g) \longrightarrow 2\ FeO\ (s) + CO_2\ (g)$

8.86 It is impossible to measure accurately the heat liberated when carbon burns to CO because the combustion cannot be stopped exactly at the CO stage. But the enthalpy changes for complete combustion of graphite and that for the conversion of CO to CO_2 can be determined. Can you suggest a way to theoretically evaluate the standard enthalpy of the formation of CO (g) ?

III **LONG ANSWER TYPE ITEMS**

8.87 Discuss some of the ways in which we can conserve energy in our houses.

8.88 Taking your own daily routine as an example, illustrate and explain what different sources of energy you utilise and what are the various types of energy changes that you come across.

8.89 "There are many natural sources of energy whose potential and capacity are vast". Support the statement with examples.

8.90 "Amongst the many kinds of reactions, perhaps combustion is the most common and abundant". Give as many example as you can to justify the statement.

8.91 "Pollution is increasing in the environment and this can be checked by proper utilisation of solar energy". Do you agree with the statement ? Please expand.

8.92 World has wide sources of energy yet there is complaint of an "energy crisis". Analyse the statement and give your views on the cause of the crisis.

8.93 Analyse the reasons for the energy crisis prevailing at present in our country.

8.94 Suggest possible methods to overcome the energy crisis in our country.

8.95 Is the term "energy crisis" an anomally when considered from the point of view of the "law of conservation of energy" ?

8.96 Why is it necessary to develop the concept of "free energy" ?

8.97 Why do we say that sun is the ultimate source of energy ? Explain with the help of a labelled energy cycle diagram.

IV NUMERICAL PROBLEMS

8.98 Calculate the heat of reaction of the following reaction.?.

$$CO_2(g) + 2H_2(g) \longrightarrow CO(g) + H_2O\ (g).$$

Given, that the standard heat of formation of CO, CO_2 and H_2O are - 110.5, - 393.8 and 241.8 kJ respectively.

8.99 The heat of combustion of ethanol is -1380 kJ. If the heat of formation of $CO_2(g)$ and $H_2O(l)$ be -396 kJ and -287 kJ respectively, calculate the heat of formation of ethanol.

8.100 Calculate the heat of formation of ethene from the following reactions:

a) $C(s) + O_2(g) \longrightarrow CO_2(g)$; H = -396 kJ

b) $H_2(g) \frac{1}{2} O_2(g) \longrightarrow H_2O(l)$; H = -287 kJ

c) $C_2 H_4(g) + 3 O_2(g) \longrightarrow 2 CO_2(g) + 2 H_2O(l)$

H = -1400 kJ

8.101 Using the following thermochemical data, calculate the enthalpy of formation of ethanoic acid.

i) $C(s) + 6_2 (g)$ ---- $CO_2 (g)$; H = -394.8 kJ

ii) $H_2(g) + \frac{1}{2} O_2 (g)$ --- $H_2O (l)$; H = -285.6 kJ

iii) $CH_3 COOH (l) + 2O_2(g)$ --- $2 CO_2(g) + 2H_2 O(l)$;

H = -882 kJ

8.102 Calculate i) G and ii) S for the reaction :

H_2O (l) H_2O (l)

If heat of fusion = 6.99 kJ mol^{-1}

8.103 Calculate i) G and ii) S for the reaction.

H_2O (l) H_2O (g, 101.325 kPa, 373 K)

If heat of vaporisation = 40.62 kJ mol^{-1}

8.104 1m^3 of C_2H_4 at STP is burnt in the oxygen, according to the thermochemical reaction :

$$C_2H_4\ (g) + 3O_2\ (g) \text{ - - } 2\ CO_2\ (g) + 2H_2O(l)\ ;$$

$$H^0 = -1410 \text{ kJ mol}^{-1}$$

Assuming a 70% efficiency, determine how much of useful heat is evolved in this reaction.

UNIT - 9

CHEMICAL EQUILIBRIUM

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice : Write the correct answer:

9.1 Of the following which is the characteristic that is applicable to systems at equilibrium ?

a) Equilibrium stands for a stable and static condition.

b) No measurable property of the system remains constant at equilibrium.

c) The equilibrium expression involving concentration of reacting substances has nothing to do with temperature.

[✓ d)] The magnitude of the equilibrium constant is an indication of the extent to which the reaction proceeds before reaching equilibrium.

9.2 Which of the following is correct from the point of view of Le Chatelier's principle ?

a) If a system is at equilibrium and the partial pressure of one of the reactants in the gas phase is increased then the system will re-adjust to decrease the partial pressure of that reactant.

b) When the total pressure is increased in a homogeneous case then the system will react in such a way as to decrease the total number of molecules, for systems involving gases.

c) If a system at equilibrium is subjected to a change which displaces it from the equilibrium, a net reaction will occur in a direction that counteracts the change.

[✓ d)] All statements (a, b, c), above.

9.3 Identify the correct equation :

a) $K_p = K_c (T)^{\Delta n}$

b) $K_c = K_p (RT)^{\Delta n}$

[✓ c)] $K_c = \dfrac{K_p}{(RT)^{\Delta n}}$

d) $K_p = \dfrac{K_c}{(RT)^{\Delta n}}$

9.4 Which of the following statements is correct ?

a) A catalyst changes the equilibrium constant.

b) A catalyst speeds up only the forward reaction.

c) A catalyst speeds up only the backward direction.

[✓ d)] A catalyst speeds up both forward and backward reactions.

9.5 For the following reaction

$$A(g) + B(g) \rightleftharpoons C(g) + D(g), \quad K_c = 1,$$

which of the following statements is true ?

a) [A] = [B] = [C] = [D]

b) [A][B] = [C][D]

c) [A] = [B] and [C] = [D]

d) [A][B] = [C][D] = 1

[illegible] At equilibrium [illegible] reaction is [illegible]

a) [illegible]

b) [illegible]

c) [illegible]

d) [illegible] products

[illegible] Which of the following [illegible] favoured by lowering [illegible]?

a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

b) [illegible] + 3 [illegible] $\rightleftharpoons$ [illegible]

c) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$

d) [illegible] + $I_2 \rightleftharpoons$ HI

[illegible] Which of the following [illegible] of [illegible] Δ

a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

b) [illegible] + [illegible] $\rightleftharpoons$ $2NH_3$

c) [illegible] + [illegible] $\rightleftharpoons$ [illegible]

d) SO_2 + [illegible] $\rightleftharpoons$ SO_3

9.9 Which of the following gaseous reactions would be favoured by increase in pressure ?

a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

b) $2\ NH_3 \rightleftharpoons N_2 + 3\ H_2$

c) $N_2 + O_2 \rightleftharpoons 2\ NO$

[✓ d)] $2\ SO_2 + O_2 \rightleftharpoons 2\ SO_3$

9.10 If is the degree of ionisation, c the concentration of a weak electrolyte and K_a the acid ionisation constant, then the correct relationship between x, c and K_a is :

a) $\alpha^2 = \sqrt{\frac{K}{C}}$

b) $\alpha^2 = \sqrt{\frac{C}{K_a}}$

[✓ c)] $\alpha = \sqrt{\frac{K_a}{C}}$

d) $\alpha = \sqrt{\frac{C}{K_a}}$

9.11 Which of the following equations does not represent a heterogenous equilibrium ?

[✓ a)] $CH_3\ COOH(l) + C_2H_5OH(l) \quad CH_3\ COOC_2H_5(l) + H_2O(l)$

b) $3\ Fe(s) + 4\ H_2O(g) \quad Fe_3\ O_4(s) + 4\ H_2\ (g)$

c) $CaCO_3(s) \quad CaO(s) + CO_2(g)$

d) $Fe_3O_4(S) + H_2(g) \rightleftharpoons 3\ Fe(s) + 4\ H_2O(g)$

9.12 From the following statements concerning vapour pressure, identify the statement which is not correct:

a) Vapour pressure of a liquid increases with rise of temperature.

b) Different liquids have different equilibrium vapour pressures at the same temperature.

c) Intensity of smell given by a liquid depends on the volatility of the liquid.

d) Liquids which have lower vapour pressures are more volatile.

9.13 Of the following statements concerning equilibrium vapour pressure of water, identify the statement which is not correct :

a) When equilibrium is reached, the pressure exerted by the water molecules remains constant and this is called the equilibrium vapour pressure of water.

b) At equilibrium, rate of evaporation of water is equal to the rate of condensation.

c) The equilibrium vapour pressure of water increases with decrease temperature.

9.27 Equilibrium constant is independent of the speed with which equilibrium is attained.

9.28 Equal number of moles of all acids (irrespective of strong or weak acid) furnish equal number of moles of hydronium ions in solution, provided the temperature remains constant.

9.29 In qualitative cation analysis cations are grouped on the basis of solubility product.

9.30 Change of state of water at 273 K and 101.325 kPa is an example of physical equilibrium.

9.31 In the Haber's process once equilibrium is established, addition of N_2 increases the yield of NH_3 .

9.32 Removal of NH_3 by liquifaction from the site in Haber's process increases the production of ammonia.

9.33 Keeping the temperature constant, the production of ammonia will become at least twice if the size of the container is halved.

9.34 Introducing Fe-MO in minute quantities in Haber's Process decreases the ammonia production.

9.35 In a reaction, a catalyst brings about favourable change in the equilibrium constant and thus increases the yield.

9.36 Catalysts alter the rates of reactions.

9.37 Catalysts are active under specific conditions.

9.38 Catalysts change the equilibrium constant.

9.39 For the reaction

$$N_{2(g)} + 3\ H_2\ (g) \rightleftharpoons 2\ NH_3(g) + Heat,$$

a) the forward reaction is endothermic

b) the forward reaction is favoured by removing heat

c) the backward reaction is favoured by increasing the temperature

d) The backward reaction is favoured by increasing the amount of nitrogen.

9.40 a) Rate of reaction is directly proportional to the active masses of the reactants

b) For reactions in the liquid phase the active masses are written as moles litre^{-1} or M.

c) For a gas in equilibrium, the value of active mass cannot be expressed in terms of partial pressure.

d) The phenomenon that : the mass of a gas dissolved in a given mass of a solvent at any temperature is proportional to the pressure of the gas above the solvent, was studied by Gulberg and Waage.

9.41 Lewis defined bases as species (charged or uncharged) which can donate an electron pair.

9.42 If the base is a strong base, then the conjugate acid will also be strong.

9.43 In qualitative analysis, the separation and identification of metal ions, such as Cu^{+2}, Zn^{+2} etc. is possible mainly due to the difference in the solubility products of their sulphides.

(D) Matching type items:

9.44 Match the items given in list A with relevant answers given in list B by indicating the serial numbers of items of list A against that of list B.

	List A		List B
	scientist		connected with development of concept/law
i)	Arrhenius	a)	H^+ and (OH) producer conceptfor acids and bases.
ii)	Le Chatelier	b)	electron pair donor/acceptor concept for acids and bases.
iii)	Bronsted-Lowry Theory	c)	proton donor/acceptor concept for acids and basis.
iv)	Gulberg and Waage	d)	concept of tendency of systems at equilibrium to retain equilibrium
v)	Lewis	e)	the law of equilibrium
		f)	concept of catalysis.

9.45

	List A equation		List B connected concept
i)	$N_2(g)+3H_2(g) \quad 2NH_3(g)$	a)	heterogeneous equilibrium
ii)	$CaCO_3(s) \quad CaO(s)+CO_2(g)$	b)	homogeneous equilibrium
iii)	$H_2O+NH_3 \quad NH_4^+ + OH^-$	c)	conjugate acid base pair
iv)	$H_3O^+ \quad OH^-$	d)	Lewis acid base concept
v)	$H_3N : + BF_3 ---- H_3N -- BF_3$		
		e)	solubility product
		f)	ionic product of water

9.46

	List A definition of acids		List B connected name of concept/law
i)	Acids are substances that taste sour.	a)	Bronsted Lowry' concept
ii)	Acids are substances that produce H^+.	b)	Lewis' theory
iii)	Acid is a proton donor.	c)	early concept
iv)	Acids are species which can accept an electron pair .	d)	Arrhenius' theory
		e)	Le Chatelier's principle
		f)	Henry's law.

II SHORT ANSWER TYPE ITEMS

9.47 While proceeding to precipitate IVth group cations in qualitative analysis can NH_4NO_3, be used instead of NH_4OH ? Give reasons.

9.48 Why is the Lewis concept more useful than the Brönsted Lowry concept ?

9.49 Under what condition is a substance precipitated from its solution ?

9.50 What will be the neutral pH (i.e. pH of water) if the ionic product of water is 49×10^{-14} ?

9.51 Give the conjugate base of H_2SO_4 when it is dissolved in water.

9.52 Why is AgCl precipitate soluble in excess NH_4OH ?

9.53 Is it possible to get precipitates of $Fe(OH)_3$ at pH2 ?

9.54 Illustrate with equations why $Al(OH)_3$ is soluble both in acids and alkalies.

9.55 Why are $CuSO_4$ acidic, Na_2SO_4 neutral and CH_3COONa basic in solution ?

9.56 What are amphoteric compounds ? Give examples of such compounds, and show their amphoteric characteristics through balanced equations.

9.57 What is Henry's law ?

III LONG ANSWER TYPE ITEMS

9.58 What do you understand by Le Chatelier's principle ? Give examples to illustrate your answer.

9.59 Discuss with examples, the different theories of acids and bases.

9.60 Discuss the effects of : changes in concentration, changes in temperature and catalysts on a system at equilibrium.

9.61 Discuss the importance of solubility product in qualitative analysis.

9.62 For the reaction

$FeCl_3\,(aq) + 3NH_4CNS(aq) \qquad Fe(CNS)_3\,(aq) + 3NH_4Cl(aq)$

at constant temperature, how will the equilibrium be affected,

a) when $FeCl_3$ solution is added to the reaction mixture ;

b) when NH_4SCN concentration is increased ;

b) When $FeCl_3$ and NH_4CNS are added simultaneously to the system ;

d) when NH_4Cl is added to the system ;

e) when NH_4Cl and $FeCl_3$ are added simultaneously.

IV NUMERICAL PROBLEMS

9.63 At high temperature CO_2 is reduced by hydrogen gas to produce CO. This equilibrium constant K_p is found to be 1.6. What will be the value of K_c.

9.64 1.00 mol of HI is placed in a 5.00 L container at 731 K. What are the concentration of HI, H_2 and I_2 after equilibrium has been established at this temperature ? (Given, $K_{eq} = 2.06 \times 10^{-2}$).

9.65 At the boiling point the esterification reaction between ethanoic acid and ethanol reaches the state of equilibrium. If the value of equilibrium constant is 4, calculate the extent of esterification. The esterification reaction can be represented as :

$$HAc + Et\,OH \rightleftharpoons EtAc + H_2O$$

9.66 At 1000 K SO_2 (g) and O_2 (g) are introduced in a 5 L flask. After some time, the system is found to contain 0.85 mol of SO_3, 0.58 mol of O_2 and 0.15 mol of SO_2 respectively. Whereas when the same mixture at the same temperature is introduced in a 10 L flask, the analysis showed the concentration to be 0.68 mol of SO_3, 0.16 mol of O_2 and 0.32 mol of SO_2. From the above date conclude that equilibrium constant is independent of volume change.

9.67 For the equilibrium

$$2\ SO_3\ (g) \qquad 2\ SO_2\ (g) + O_2\ (g)$$

value of the equilibrium constant K is 4.8×10^{-3} at 973. K. At a particular time, if the concentrations of the above 3 substances in a container are SO_3 = 0.60 M, SO_2 = 0.15 M, O_2 = 0.025 M,

how will the concentration change, i.e. in which direction will the reaction proceed, as the system approaches equilibrium, if the temperature is maintained at 973 ?

9.68 What are the pH and pOH of a 0.016 M NaOH solution ?

9.69 Calculate the pH of water to which 10^{-9} M HCl has been added at room temperature.

9.70 a) Calculate the H_3O^+, Cl^- and OH^- in a solution that is 0.03 M in HCl at 298 K.

b) What will be the OH^- at 373 for the same solution when the $K_w = 51 \times 10^{-14}\ mol^2\ L^{-2}$.

9.71 a) To a litre of 0.4 M ammonia solution, 0.2 mol NH_4Cl is added. If the dissociation constant of the base is 1.8×10^{-5}, calculate the amount of hydroxyl ions in the solution.

b) What will be the concentration of free OH^- if no NH_4Cl is added to the above solution ?

9.72 Calculate H^+ in a solution prepared by adding 0.10 mol each of CH_3COOH (ethanoic acid) and HCN to enough water to make 1.0 L of solution :

Given,

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^- \quad K_a = 1.8 \times 10^{-5}$$

$$HCN \rightleftharpoons H^+ + CN^- \quad K_a = 4.0 \times 10^{-10}$$

$$H_2O \rightleftharpoons H^+ + OH^- \quad K_w = 1.0 \times 10^{-14}$$

9.73 A solution at 298 K contains twice as many hydroxyl ions as pure water. What is its pH ?

9.74 The ionic product of water at 373 K is 55 times that at 298 K. Calculate the pH of water at 373 K

9.75 The solubility of $PbSO_4$ is 0.038 g L^{-1}. Calculate the solubility product of $PbSO_4$. (Given atomic weights of Pb = 207, S = 32).

9.76 The solubility product of Pb $(IO_3)_2$ is 2.5×10^{-13}. What is the solubility of Pb $(IO_3)_2$ in mol L^{-1} ?

9.77 Calculate the NH_4^+ concentration (derived from NH_4Cl needed to prevent $Mg(OH)_2$ from precipitating in 1L solution which contains 0.010 mol of ammonia and .0010 mol of Mg^{2+}. The ionization constant of ammonia is 1.75×10^{-5}. The solubility product of $Mg(OH)_2$ is 7.1×10^{-12}.

9.78 Calculate the solubility of $Mg(OH)_2$ at 298 K in

a) pure water, and b) in a solution having a pH = 12.00 given, K_{sp} $Mg(OH)_2 = 8.9 \times 10^{-12}$ at 298 K.

9.79 Will a precipitate form if 25×10^{-3} L of 14×10^{-9} M NaI and 35.0×10^{-3} L of 7.9×10^{-7} M $AgNO_3$ are mixed ? (K_{sp} for AgI is 3.5×10^{-17}).

UNIT - 10

REDOX REACTIONS

I. OBJECTIVE TYPE ITEMS

(A.) Multiple choice type : Write the correct answer:

10.1 In the reaction $2\ Fe + 3\ Cl_2 \rightarrow Fe_2Cl_6$,

- a) iron is oxidised
- b) chlorine is oxidised
- c) iron chloride is oxidised
- d) iron is reduced

10.2 Oxidation number of an alkali metal is :

- a) -2
- b) -1
- c) +1
- d) +2

10.3 In the following reaction,

$2\ Cu_2 S + 3\ O_2 \rightarrow 2\ Cu_2O + 2\ SO_2$

- a) copper is reduced
- b) sulphur is oxidised
- c) copper is oxidised
- d) sulphur is reduced

10.4 Identify the incorrect statement regarding a half cell.

- a) A half cell by itself causes movement of charges.

b) Once equilibrium is reached between the electrode and the solution, there is no further net displacement of charges.

c) Different metal/metal ion combinations would have different electrode potentials.

d) To have a net flow of current, two half cells are to be combined such that the electrons removed from one electrode is fed to the other electrode.

10.5 The extent of a chemical reaction will not depend on :

a) the strength of the current passed through the cell

b) the time for which the current is passed

c) the size of the cell

d) whether the redox reaction involves one or more electron

10.6 Identify the incorrect statement regarding oxidation numbers :

a) In its compounds, hydrogen can have an oxidation number other than +1.

b) In its compound flourine can have an oxidation number other than -1.

c) Algebraic sum of oxidation number of all atoms in a neutral molecule is 0.

d) Oxidation number of an element in its elemental form is 0.

10.7 A chemical reaction

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$ occurs spontaneously because, the change in free energy is :

a) positive
b) negative
c) zero
d) equal to ΔS

10.8 Standard electrode potential refers to the electrode potential of :

a) the metal alone
b) the metal in combination with its ions of any concentration
c) the metal in combination with 1 mol L^{-1} solution of its ions
d) the metal in combination of with 1 M solution of its ions

10.9 A salt bridge is provided between two half cells for

- a) avoiding mixing of solutions
- b) high resistance electrical connection
- c) low resistance electrical connection
- d) increasing EMF of the cell

1.10 Which of the following does not conduct electric current ?

- a) molten KCl
- b) molten Pb
- c) $AgNO_3$ solution
- d) methanol

(B) Completion type items

Complete the following:

10.11 a) A reaction in which electrons are transfered from one reactant to another is called ------- .

b) A --------- electrode is taken as standard reference electrode.

c) A set up that generates electricity from a chemical reaction called a i) cell or an ii) cell

d) In the standard hydrogen electrode half cell, the concentration of the acid is -----------.

e) The charge assigned to an atom of a compound or of an ion is called its -------

10.12 a) Oxidation involves ____i)____ in oxidation number and reduction involves a ____ii)____ in oxidation number.

b) If E cell is positive, the cell reaction is ------.

c) In the cell reaction, Zn + 2 Ag^+ ---> Zn^{+2} + 2 Ag; Zn is ____i)____ and Ag^+ is ____ii)____

d) Oxidation number of oxygen/in a compound is generally ____i)____ but in H_2O_2 it is ____ii)____ and in F_2O it is ____iii)____

e) When electric current is passed through molten NaCl sodium is deposited at ____i)____ and chlorine is evolved at ____ii)____ ___ .

10.13 a) The system of using Roman numerals in naming compounds of metals is known as ____i)____ notation. This notation is not generally used for ____ii)____ .

b) Oxidation is a loss of ____i)____ or gain in ____ii)____ valence.

c) Passage of electricity through electrotypos leading to chemical change is known as ________.

d) The electrode at which oxidation takes place is the ____i)____ and the electrode at which reduction takes place is the ____ii)____ .

c) When a current flows between two points, a difference of potential is said to exist between them. The potential difference is given a special name ____________.

10.14 a) Daniel cell converts ___i)___ energy to ___ii)___ energy.

b) In the reaction :

$2 Cu + 4 H^+ + O_2 \longrightarrow 2 Cu^{2+} + 2 H_2O$

Copper is ___i)___ by forcing air through a hot mixture of Cu and dil H_2SO_4, while H^+ ions are ___ii)___.

c) In the reaction :

$3 Fe + 4 H_2O \longrightarrow Fe_3O_4 + 4 H_2$

___i)___ is oxidised since it has ___ii)___ electrons.

d) Plantinised platinum is used in S.H.E. as a ___i)___ to speed up equilibrium between H_2 and ___ii)___.

e) In S.H.E. a ___i)___ electrode is dipped in ___ii)___ solution of H_3O^+ at 298K and pure ___iii)___ gas maintained at ___iv)___ atmosphere pressure is bubbled over ___v)___ electrode.

(C) True and false type items

Classify the following statements as true(T) and false (F)

a) Oxidation and reduction reactions cannot occur simultaneously.

b) Direction of current, by convention is opposite to the direction of flow of electrons.

c) A Daniel cell is represented as :

$$Ni/Ni^{2+} (aq) \,||\, Ag^{+} (aq) \,,\, Ag.$$

d) A metals higher than a particular metal in the activity series is a better oxidising agent in aqueous solutions than the one that lies below it.

e) If E cell is negative, the cell reaction is spontaneous.

10.16 a) 1 Faraday of electricity = 96500 coulombs

b) The substance which accepts electron/s is an oxidising agent

c) The substance accepting electron/s is oxidised.

d) Reduction-oxidation involves transfer of electron/s

e) According to IUPAC the term "Standard Potential" should be used for reactions written as reduction reactions.

(D) Matching Type items

10.17 Match the items in list A with relevant items in list B, by indicating the serial numbers of item by list A against that of list B.

List A	List B
i) ions having positive charge are called	a) −1
	b) anions
7 ii) oxidation number of flourine in	
8 iii) ions having negative charge are called	c) 7
iv) oxidation number of magnesium ion is	d) cations
v) the algebraicsum of the oxidation number of all atoms in neutral molecule is	e) +2
	f) [illegible]
	g) +1

II SHORT ANSWER TYPE ITEMS

10.18 Zn rod is immersed in $CuSO_4$ solution. What will you observe after an hour? Explain your observation in terms of redox reactions.

10.19 How would you identify the cathode and the anode in an electrochemial cell ?

10.20 When a Cu strip is dipped in Cu^{2+} solution, on what factors do the potential difference at equilibrium depend?

10.21 Calculate the oxidation number of all the atoms in the molecules/ions given below.

i) K_2CrO_4 ii) $K_2Cr_2O_7$ iii) $C_{12}H_{22}O_{11}$

iv) $S_2O_3^{2-}$

10.22 Why does copper not react with dil H_2SO_4 under normal conditions ? Explain on the basis of the activity series.

10.23 Differentiate between electrolytic cell and electrochemical cell.

10.24 How did the electrolysis process help the scientists to arrive at the conclusion that H_2O is made up of 2 parts hydrogen and one part of oxygen? Write the electrode reactions also.

10.25 Balance the following equation by the oxidation number method.

i) $Fe^{2+} + H^+ + Cr_2O_7^{2-} \rightarrow Cr^{3+} + Fe^{3+} + H_2O$

ii) $MnO_2 + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$

iii) $I_2 + NO_3^- \rightarrow NO_2 + IO_3^-$

iv) $MnO_4^{2-} \rightarrow MnO_2 + MnO_4^-$

v) $I_2 + S_2O_3^{2-} \rightarrow I^- + S_4O_6^{2-}$

10.26 Calculate the oxidation number of phosphorous in PO_4^{3-}, HPO_3^{2-}.

10.27 Calculate the oxidation number of S in $Na_2S_4O_6$, Na_2SO_3, Na_2SO_4.

10.28 Why is potassium a highly reactive metal whereas Au is a noble metal?

10.29 Differentiate between potential difference and electromotive force.

10.30 How will you represent a Daniel Cell? Name the cathode and the anode.

10.31 Write the oxidation and reduction reactions separately from the following redox reaction:

$$2Fe + 2H_2O + O_2 \rightarrow 2Fe(OH)_2$$

10.32 Write the reactions which take place on anode and cathode, when electric current is passed through $MgCl_2$ solution.

10.33 How would you represent the galvanic cell for each of the overall cell reactions given below?

i) $Zn(s) + 2Ag^+ \rightarrow 2Ag(s) + Zn^{2+}$

ii) $Sn + Cu^{2+} \rightarrow Sn^{2+} + Cu$

iii) $2Fe(s) + 2Cl \rightarrow 2Fe^{2+} + Cl_2(g)$

iv) $2Cr + 3Cu^{2+} \rightarrow 2Cr^{3+} + 3Cu(s)$

10.34 Which of the following electrodes will act as anodes, when connected [illegible]

i) Al/Al^{3+}, $E^0 = -1.66$

ii) Fe/Fe^{2+}, $E^0 = -0.44$

iii) Cu/Cu^{2+}, $E^0 = +0.34$

iv) $F_2(g)|2F^-(aq)$, $E^0 = +2.87$

10.35 Write the anodic and cathodic reactions separately for the over all cell reactions:

i) $NiO_2(s) + 2H_2O + Cd(s) \rightarrow Ni(OH)_2 + Cd(OH)_2$

ii) $HgO(s) + H_2O + Zn(s) \rightarrow Hg(l) + Zn(OH)_2$

iii) $PbO_2(s) + 2H_2SO_4 + Pb(s) \rightarrow 2PbSO_4 + 2H_2O$

10.36 What changes will occur if slightly higher current than the Galvanic current is sent in the opposite direction from an external source in the following galvanic cells?

i) $Zn/ZnSO_4 \vdots CuSO_4/Cu$, $Zn(s)+Cu^{2+}(aq) \rightarrow Cu(s)+Zn^{2+}(aq)$

ii) $Al/AlCl_3 \vdots HCl/Pb$; $2Al+6Cl^- \rightarrow 2Al^{3+} + 3Cl_2(g)$

10.37 Which of the following reactions are feasible considering each metal to be in contact with 1M conc. of its ions?

(Hint: $\Delta G^o = -nE^oF$)

$Hg(s) + Cu^{2}(aq) \rightarrow Hg^{2+}\ Cu(s)$

$Zn(s) + Hg^{2+}(aq) \rightarrow Zn^{2+} + Hg(s)$

$Al(s) + 2H^+(aq) \quad Al^{3+} + H_2(g)$

Given

$E_{o\,Cu/Cu^{2+}} = 0.34$

$E_{o\,Hg/Hg^{2+}}$ [illegible]

$E_{o\,H_2/H^+} = 0.00$

$E_{o\,Zn/Zn^{2+}} = -0.76$

$E_{o\,Al/Al^{3+}} = -1.66$

10.38 How is the process of electrolysis useful in industry?

10.39 Why cannot we store copper sulphate solution in an an iron vessel ?

10.40 Fe decomposes stem while Cu does not. Why.?

10.41 Calculate the oxidation No. of the underlined elements in the following molecules:

$Na_2\underline{B_4}O_7$, $\underline{Os}O_4$, $(NH_4)_6\underline{Mo}_7O_{24}$,

$\underline{Fe}CNS$, $H_6\underline{Te}O_6$.

10.42 Why is a reference standard needed for measuring an electrode potential ?

10.43 What is a standard hydrogen electrode ? How is it used to measure electrode potential ?

10.44 Discuss the function of a salt bridge by explaining how the circuit is completed. Write its significance.

III. LONG ANSWER TYPE ITEMS

10.45 Explain redox reaction on the bais of electron transfer. Give suitable examples.

10.46 On the basis of the electrochemical series, suggest whether following reactions will proceed or not:

i) $Cu + Zn^{2+} \longrightarrow Zn + Cu^{2+}$.

ii) $Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe$.

iii) $Br_2 + 2Cl^- \longrightarrow Cl_2 + 2Br^-$.

iv) $Cu + 2H^+ \longrightarrow Cu^{2+} + H_2$.

v) $Fe + Cd^{2+} \longrightarrow Fe^{2+} + Cd$.

given: $Mg(aq)+2e^- \rightarrow Mg(s)$ − 2.37V

$Zn^{+2}+2e^- \rightarrow Zn(s)$ − 0.76V

$Fe^{+2}(aq)+2e^- \rightarrow Fe(s)$ − 0.44V

$Cu^{+2}(aq)+2e^- \rightarrow Cu(s)$ + 0.34V

$Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$ + 1.08V

$Cl_2(aq) + 2e^- \rightarrow 2Cl^-(aq)$ + 1.36V

10.47 Draw a well labelled diagram of a Daniel Cell and a Dry Cell. Write the electrode reactions. Why is a common dry cell not rechargeable ?

10.48 Write the name of any cell in which chemical energy is converted into electrical energy. Write the electrode reactions and draw a well labelled diagram of the cell.

IV. NUMERICAL PROBLEMS

10.49 A standard copper-copper ion electrode is combined with a standard hydrogen electrode to make a cell. The cell voltage is measured as 0.34V at 298K, and electrons are f[illegible] the internal circuit from the hydrogen electrode. What is the potential for the standard copper-copper ion electrode?

10.50 Predict whether the following reaction can occur (all reactants and products in their standard states).

$Sn^{2+} + 2I^- \rightarrow Sn(s) + I_2$

given, $2e^- + Sn^{2+} \rightarrow Sn(s)$ $E^0 = -0.14V$

$2e^- + I_2 \rightarrow 2I^-$ $E^0 = +0.54V$

10.51 Calculate the equilibrium constant at 298K for the reaction $Cu(s) + Cl_2(g) \rightarrow CuCl_2(aq)$

given, $E^o\ (Cl_2/Cl^-) = 1.36$ volts and

$E^o\ (Cu^{2+}/Cu) = 0.34$ volts

10.52 Knowing that K_{sp} for AgCl is 1.8×10^{-10}, calculate E for silver - silver chloride electrode immersed in 1M KCl at 298K. Given $Ag^+ + e^- \rightarrow Ag$, $E^o = 0.799V$.

10.53 At equilibrium concentration of Fe^{2+} and Fe^{3+}, what must $[Ag^+]$ be so that the voltage of the galvanic cell made from the (Ag^+/Ag) and (Fe^{3+}/Fe^{2+}) electrode equals zero ? Given, $E^o\ Ag^+/Ag = 0.799$ V and $E^o\ Fe^{3+}/Fe^{2+} = 0.771$ V.

10.54 Calculate the cell potential of a Daniell cell on the basis of Nernst equation, if the concentration of Cu^{2+} is 0.001 M and that of Zn^{2+} is 0.1 M. Given, $R = 8.31\ JK^{-1}\ mol^{-1}$, $T = 298K$, $F = 96500$ coloumbs, $E^o\ Cu = 0.34$ V, $E^o Zn = -0.76$ V.

10.55 For an electrolytic cell, cell reaction is as follow:

$$2\ Fe^{3+}(aq) + Sn^{2+}(aq) \rightarrow 2Fe^{2+}(aq) + Sn^{4+}(aq)$$

Calculate the standard free energy for the reaction

Given,

$E^o Sn^{4+}/Sn^{2+} = 0.15$ V

$E^o Fe^{3+}/Fe^{2+} = 0.77$ V.

10.56 Calculate the cell potential for the cell :

$Cr/Cr^{3+}\ (.01M) \| Fe^{2+}\ (.01M) / Fe$

Given, $E^o\ Fe^{2+}/Fe = -0.44$ V and

$E^o\ Cr^{3+}/Cr = -0.74$ V

10.57 Given,

i) Al/Al^{3+} $E^0 = -1.65V$.

ii) Cu/Cu^{2+}, $E^0 = +0.34V$

iii) Fe/Fe^{2+}, $E^0 = -0.44V$.

iv) $2F^-(aq)/F_2(g)$ $E^0 = -2.87V$.

Write the EMF of the cells found from the combination of

a) i) + ii)

b) ii) + iii)

c) i) and iv)

d) iii) and iv)

10.58 Calculate the EMF of the following cells:

a) $Ni(s)/Ni^{2+}(aq)\ (1M) \| Ag^+\ (1M)/2Ag(s)$

b) $Ni(s)/Ni^{2+}\ (0.1M) \| Ag^+\ (0.1M)/2Ag(s)$

c) $Ni(s)/Ni^{2+}\ (0.1M) \| Ag^+(0.01M)/2Ag(s)$

Given

$E^0_{Ni} = -0.25$

$E^0_{Ag} = +0.80$ Volt

$R = 8.31\ JK^{-1}\ mol^{-1}$

$F = 96500$ coloumbs

$T = 298\ K$

UNIT - 11

RATES OF CHEMICAL REACTIONS

I. OBJECTIVE TYPE ITEMS

(A) Multiple choice type : Write the correct answer

11.1 The factor that does not affect the rate of a chemical reaction in solution is :

a) the concentration of the reactants

b) the temperature of thr reactants

c) the presence of a catalyst

d) a change in pressure.

11.2 Given a reaction $A + B \dashrightarrow 2C + D$.

Identify the incorrect statement :

a) Rate of disappearance of A = rate of disappearance of B.

b) Rate of disappearance of A = $\frac{1}{2}$ rate of appearance of C.

c) Rate of disappearance of A = 2 rate of appearance of C.

d) Rate of disappearance of B = $\frac{1}{2}$ rate of appearance of C.

11.3 An ideal catalyst :

a) changes the extent of the completion of a reaction

b) speed up the attainment of equilibrium

c) does not alter the time it takes to reach an equilibrium condition

d) does not affect the activation energy of the backward reaction.

11.4 Which of the following statements does not concern Arrhenius's theory ?

a) Every encounter between reactant molecules does not lead to a reaction resulting in a product.

b) For an encounter to be effective in producing a product, the energy of the colliding molecules should be greater than the activation energy.

c) The reaction rate should increase with increase in energy of the reactant molecules.

d) Reaction rate is independant of the energy of the reactant molecules.

11.5 If the rate of reaction is expressed as $k[C_A]^1[C_B]^2$, which of the following statements is incorrect ?

a) k is called the rate constant

b) C_A and C_B are the concentration terms

c) The superscripts 1 and 2 in the equation represent the order of the reaction

d) The reaction is 1st order with respect to A and 2nd order with respect to B.

11.6 For Rate = $k [H_2]^1 [Br_2]^{\frac{1}{2}}$, the overall order of the reaction is

a) $\frac{1}{2}$
b) 0
c) $1\frac{1}{2}$
d) 1

11.7 Increase in Reaction rate at higher temperature in a chemical reaction is due to :

a) increase in size of the molecule
b) increase in the fraction of molecules possessing higher energy
c) decrease in energy of activation of the reaction
d) increase in concentration of reactant in solution

11.8 A catalyst is considered to be one

a) which increase the energy of activation of a chemical reaction
b) which lowers the energy of activation of a reaction
c) which increases the no. of collision between molecules
d) which decreases the no. of collisions between molecules ;

11.9 Which of the following statements regarding a catalyst is incorrect ?

- a) A catalyst get released in its original chemical state at the end of the reaction.
- b) A catalyst decreases the activation energy only of the forward reaction.
- c) A catalyst decreases the time a reaction takes to reach an equilibrium condition.
- d) A catalyst alters the path to one which has a lower energy of activation.

11.10 The overall rate of a reaction is governed by :

- a) the rate of the fastest intermediate step
- b) the rate of the slowest intermediate step
- c) the sum total of the rates of all the intermediate steps
- d) the average of the rate of all the intermediate steps.

(B) Complition type items

Complete the following :

11.1 a) Photosynthesis and photography have a common factor since for both -------- is used for initiating the chemical reaction involved.

b) A convenient unit commonly used for expressing reaction rate is ---------

c) In the reaction A + B ---> 2 C, if the reaction is 1st order with respect to reactant A and 2nd order with respect to reactant B, then the rate of the foreward reaction = k --------.

d) Light energy may be sufficient even to break chemical bonds and form highly reactive intermediates called ----------

e) 1 pico second is -------- seconds.

11.12 a) Extremely fast reactions can be studied with the help of ----------------

b) The order of the reaction is determined by the total number of molecules of the reactant whose concentration actually ---------

c) The rate constant for a specific reaction is independant of the ------ of the reactants

d) The increased dispresion of one reactant in another -------- the rate of reaction

e) Arrhenius showed that reactants must cross a -------- before they are transformed to products.

11.13 a) The shorter the reaction life time the --------- the reaction

b) Reactants would not change to products, unless the energy of the colliding particles is greater than a threshold called the ----------

c) Arrangement of atoms corresponding to the maximum of an energy diagram is called ----------

d) Human life process depend on catalysts called ----------

e) Most of the chemical reactions involve many intermediate step called --------

C True and false type items:

Classify the following statements as (T) true or false(F).

11.14 a) Rate of chemical reaction is constant in the absence of a catalyst.

b) Average and instantaneous rates are the same.

c) Average rate of a reaction is determined with the help of the data ontime taken to complete a certain percentage (say 20%) of the reactant to disappear.

d) Longer the reaction life time, faster the reaction.

e) Slowest step determines the rate of the overall reaction.

11.15 a) In the presence of a catalyst, activation energy of the reaction goes up.

b) Order of a reaction can never be zero.

c) The different rates are identical if the stoichiometric coefficients of the different species participating in the reaction are the same.

d) Catalysts always increase the rates of the reactions

e) An increase in concentration of reactants increases the rate of the reaction.

11.16 The following factors affect the rate of encounter between the reactant molecules :

a) concentration of the reactants,
b) mixing or stirring the solution,
c) increasing the pressure of the reactant gases,
d) increasing the particle size of the reactants,
e) lowering the temperature of the reactants.

11.17 a) Every reaction feasible from the consideration of the energy always takes place.

b) A mixture of reactants may be thermodynamically unstable but kinetically stable.

c) It is possible to lower the energy of activation for reactants and hence increase the rate of reaction.

d) In a gaseous reaction, increase in pressure of the reactant gases increases the rate of reaction.

e) Extent of increase in the rate of a reaction can be predicted from kinetic theory which tells us about the rates of collision and rates of diffusion.

11.18 Reaction rate increases if

a) the temperature is raised

b) the energy of activation increases

c) free energy change is negative

d) an inert substance is present

e) the concentration of the reactants is increased.

(D) Matching type items:

[illegible] Match the items given in list A with relevant answers given in the list B, by indicating the serial number of items of list A against that of list B.

11.19

	List A terms		List B stands for
i)	k	a)	threshold energy
ii)	activated complex	b)	catalysts
iii)	activation energy	c)	millisecond

iv)	enzymes	d)	micro second
v)	10^{-6} second	e)	arrangement of atoms corresponding to the maximum of energy
		f)	rate constant

III SHORT ANSWER TYPE ITEMS

11.20 Increase in the higher concentration of the reactants increases the rate of a reaction. How will you explain this in the light of rate of encounters or collisions ?

11.21 Using A and B as reactants, set the equation for the rate of reaction which are :

a) zero order

b) one and a half order

c) second order

11.22 Name three examples of chemical reactions or processes where light is used to initiate the reaction.

11.23 "Most reactions slow down as they proceed". Is this a correct statement ? Justify your answer.

11.24 The esterification of ethanoic anhydride (A) and ethanol (B) can be represented as :

$$\underset{(A)}{(CH_3CO_2)O} + \underset{(B)}{C_2H_5OH} \rightarrow CH_3COOC_2H_5 + CH_3COOH$$

when the reaction is carried out in dilute hexane solution the rate may be represented by $k [A][B]$. When ethanol (B) is the solvent, the rate may be represented by $k [A]$. (The value of k are not the same in the two cases). Explain the difference in the apparent order of the reaction.

11.25 Write the order with respect to each reactant and the total order of the reaction in each of the following cases where the rate equation is given as :

a) Rate $= k [CH_3 CO C_2 H_5]^1 [H_2O]^0$.

b) Rate $= k [N_2O_5]^1$.

c) Rate $= k [CH_3COOH]^1 [CH_3 OH]^1$.

d) Rate $= k [CH_3 CHO]^{1.5}$.

11.26 Differentiate between the average rate and instantaneous rate of a chemical reaction.

11.27 "A catalyst affects the forward and backward reaction rate to the same extent". How will you justify the statement ?

11.28 Can you come to any conclusion when you compare energy of activation and the rate of reaction ?

11.29 Why is it that in the case of a solid-liquid hetero geneous system, decreasing the particle size of the solid increases the rate ?

11.30 How can you explain that fuels and oxygen (in air) coexist (till ignited) ?

11.31 What are meant by the terms : rate constant, rate of a reaction, half life of a reaction ?

11.32 What do you understand by the term activated complex and activation energy ?

III LONG ANSWER TYPE ITEMS

11.33 Write briefly about Arrhenius' theory of reaction rates.

11.34 Draw a well labelled potential energy diagram which represents an exothermic reaction, in the presence and in the absence of a catalyst.

11.35 What is meant by the term catalysis. Explain how does a catalyst work.

IV NUMERICAL PROBLEMS

11.36 What are the units of the rate constant k for,

a) a zero order reaction
b) a first order reaction
c) a second order reaction
d) a third order reaction
e) a ½ order reaction,

if the concentration of the reactant is expressed in mol L^{-1}.

(Hint : A convenient unit to express the rate is mol I^{-1} S^{-1})

11.37 The value of the rate constant k of the first order reaction $SO_2Cl_2 \rightarrow SO_2 + Cl_2$ is $\frac{1.5 \times 10^{-2}}{60}$ s^{-1}

What is the rate of decomposition of SO_2Cl_2 at the following concentration ?

a) .08 M
b) .04 M
c) .012 M
d) .01 M

(Hint : Rate = k $SO_2Cl_2^{1}$)

11.38 Hydrolysis of sucrose in presence of HCl takes place as given below :

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\substack{\text{(enzyme)}\\ \text{and}\\ H^+}]{\text{Invertase}} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

The rate of hydrolysis is found to be given as :

$$\text{Rate} = k\,[C_{12}H_{22}O_{11}]^1\,[H_2O]^0 .$$

Find the value of k when, the sucrose concentration is 0.3M. Given, the rate of hydrolysis is 0.116 $\text{mol}L^{-1}/s^{-1}$ at sucrose concentration of 0.1 M.

11.39 The data obtained for the decomposition of H_2O_2 is given below :

Time (seconds)	0	10	20	30	40	50
Concentration ($\text{mol } L^{-1}$)	0.04	0.034	0.029	0.024	0.020	0.016

Find the average rate of decomposition of H_2O_2 for

a) 0-40% decomposition
b) 0-50% decomposition
c) 0-20 seconds
d) 20-40 seconds
e) 0-40 seconds

UNIT - 12

CHEMISTRY OF NON METALS - I

I. OBJECTIVE TYPE ITEMS

(A) Multiple Choice Type: (Write the correct answer)

12.1 Which of the following is used to prepare dihydrogen in the laboratory ?

a) copper and dilute hydrochloric acid

b) copper and concentrated sulphuric acid

c) lead and dilute sulphuric acid

d) zinc and dilute hydrochloric acid.

12.2 Dihydrogen form interstitial hydride with:

a) alkali metals

b) alkaline earth metals

c) non metal

d) metals such as pt and pd

12.3 Which of the following is radioactive?

a) ^{1}H

b) ^{2}D

c) ^{3}T

d) $^{2}D^{+}$

12.4 Of the following statements regarding dihydrogen identify the statement which is not correct:

a) It is a colourless, odourless, tasteless gas.

b) It has a very low solubility in water.

c) It is a highly reactive gas.

d) It forms more compounds than any other element.

12.5 Given that i) boiling point of H_2 is 20.4 K and that of D_2 is 23.9 K, ii) melting point of H_2 is 13.8 K and that of D_2 is 18.7 K, iii) molecular mass of H_2 is 2.016 and that of D_2 4.028, which of the following processes would you think would be the most efficient for separating D_2 from H_2:

a) distillation

b) crystallisation

c) diffusion

d) chemical method.

12.6 Though a potential fuel, dihydrogen still has only limited use as a fuel. This is because:

a) it is not available in the nature in the native state

b) it is difficult to store as it is highly inflammable

c) it has a fairly high bond dissociation energy

d) it is difficult to transport.

12.7 The molecules O_2, O_3 and H_2O_2 have O-O bond. Choose among the following the correct arrangement in order of increasing bond length.

a) H_2O_2, O_3, O_2

b) O_3, O_2, H_2O_2

c) O_2, O_3, H_2O_2

d) O_2, H_2O_2, O_3

e) O_3, H_2O_2, O_2

12.8 Atmospheric ozone protects the earth's inhabitants by absorbing:

a) UV radiation

b) infra-red radiation

c) visible radiation

d) γ radiation

12.9 Hydrogen shows similarities in its chemical behaviour with halogens and may be grouped with halogens in the periodic table. Identify the statement which does not support this fact:

a) It forms numerous covalent compounds.

b) It needs one electron to attain the stable noble gas configuration.

c) It forms a diatomic molecule with itself.

d) It has only one electron in its outermost orbital.

12.10 Ordinary hydrogen undergoes reactions more rapidly than deuterium. This is because:

a) natural abundance of hydrogen is much higher than that of deuterium

b) deuterium is radioactive

c) deuterium is chemically different than hydrogen

d) deuterium has a higher mass than hydrogen.

12.11 Identify the statement which is not correct as far as preparation of dihydrogen is concerned.

a) It can be prepared by action of water or dilute mineral acids on metals.

b) It can be displaced from acids by metals below hydrogen in the electromotive series.

c) It can be produced by electrolysis of water in the presence of a small amount of acid or base.

d) It can be industrially produced by the action of **steam** on hydrocarbons or coke at high temperature.

12.12 Which of the following substances causes permanent hardness of water ?

a) calcium carbonate

b) calcium chloride

c) calcium bicarbonate

d) magnesium bicarbonate

12.13 Which of the following methods is used to remove permanent hardness of water ?

a) addition of magnesium chloride solution

b) addition of sodium carbonate solution

c) addition of calcium chloride solution

d) boiling sufficiently

12.14 Permanent hardness of water can not be removed by:

a) adding washing soda to water

b) boiling water

c) adding sodium polymetaphosphate to water

d) by passing water through ion encharged series.

12.15 Which of the following elements does not react with dioxygen directly:

a) Na

b) Pt

c) Al

d) Mg

12.16 Based on acid base characteristics, SiO_2 has similarities with:

a) MgO

b) Al_2O_3

c) Fe_2O_3

d) SO_3

12.17 Of the following properties of ozone, identify that which is not correct:

a) Ozone is diamagnetic while dioxygen is paramagnetic.
b) Ozone is more reactive than dioxygen.
c) Ozone is formed in the upper atmosphere by a photochemical reaction involving dioxygen.
d) Ozone is an isotope of oxygen.

12.18 The most economic method of production of dioxygen on an industrial scale is:

a) decomposition of oxygen rich compounds viz. $KMnO_4$, $KClO_3$
b) reaction of water on sodium peroxide.
c) fractional distillation of liquid air.
d) electrolysis of water.

12.19 The oxidation number of nitrogen in HNO_3 is:

a) -3
b) +3
c) +5
d) 0

12.20 Dinitrogen is produced commercially by:

a) the action of aqueous solution of NH_4Cl and $NaNO_2$
b) thermal decomposition of ammonium dichromate.
c) reaction of ammonia with Cuo.
d) liquifaction and fractional distillation of air.

12.21 Of the properties of NH_3 listed below, identify the one that is not correct:

a) Ammonia molecule has a trigonal pyramidal. structure with nitrogen atom at the apex.

b) In solid and liquid state it is associated through hydrogen bonds.

c) The presence of a loan pair of. electron on the nitrogen atom of the ammonia molecule makes it a Lewis acid.

d) Ammonia gas is highly soluble in water.

12.22 Ostwaldprocess is used for the manufacture of:

a) N_2O_4

b) HNO_3

c) N_2O

d) NH_3

(B) Completion Type Items

B) Complete the following:

12.23 The source of sun's energy is the fusion of __________ nuclei to form helium.

12.24 Mixture of carbon monoxide and dihydrogen is known as ______________.

12.25 Heavy water is used as a __________ in nuclear reactors.

12.26 Ozone is formed from O_2 in the upper atmosphere by ______.

12.27 Hydrogen peroxide __________ acidified potassium parmagnate to manganous salt.

12.28 Water can act both as an acid and a base and is said to be ______________.

12.29 ______________ is used to prepare deionized water in large scale from ordinary water.

12.30 The ______________ property of hydrogen peroxide is put to use in restoration of old paintings.

12.31 Oxidation state of oxygen in H_2O_2 is ______________.

12.32 The N — N bond in the N_2 molecule has a formal ________ bond character.

12.33 Liquid nitrogen finds use as a ____________.

12.34 Nitric acid can be prepared in the laboratory by heating ______________ with concentrated sulphuric acid.

12.35 Ammonia molecule is __________ in shape.

12.36 Nitric oxide and nitrogen dioxide are used in the manufacture of ____i)____ and ____ii)____ fertilisers.

12.37 _______ has been used as an oxidiser for rocket fuel.

12.38 a) $4NH_3 + 5O_2 \xrightarrow[\text{Catalyst}]{\text{Pt/Rh}}$ ______ $+ 6H_2O$

b) $3NO_2 + H_2O$ ______ $+ NO$

c) $Cu + 4HNO_3(\text{conc})$ ______ $+ 2NO_2 + 2H_2O$

d) $4Zn + 10HNO_3(\text{conc})$ ______ $+ NH_4NO_3 + 3H_2O$

e) $I + 10HNO_3 \longrightarrow 2HIO_3 +$ ______ $+ 4H_2O$

C) **True and false type items**

Classify the following statements as true (T) and false(F)

12.39 a) Heavy hydrogen is the other name of the isotope of hydrogen called tritium.

b) Hydrogen is prepared from zinc and dil hydrochloric acid through a displacement reaction.

c) Because of its high bond dissociation energy, dihydrogen is not particularly reactive.

d) Hydrogen forms interstitial hydride with all metals.

e) In Haber's process dihydrogen and di nitrogen react to from nitric acid.

12.40 a) The naturally occuring isotopes of oxygen are

$${}^{16}_{8}O \qquad {}^{17}_{8}O$$

b) Photosynthesis is beloived to be the main source of all dioxygen in the atmosphere.

c) Both oxygen and ozone are paramagnetic.

d) Ice always exists in a particular type of [illegible] crystalline form.

e) Temporary hardness can be removed by the addition of a calculated amount of lime.

12.41 a) Nitrogen forms a variety of compounds in all oxidation states ranging from-3 to +5.

b) Dinitrogen is chemically unreactive at ordinary temperatures.

c) The presence of a loan pair of electron on the nitrogen atom of ammonia molecule makes it a Lewis acid.

d) In gaseous state, HNO_3 exists as a planar molecule.

e) The 'brown ring test' for nitrates is performed by adding dilute ferric sulphate to an aqueous solution containing nitrate ion.

(D) Matching type items:

Match the items in list A with the items in List B by indicating the serial number of items of list A against that of list B.

12.42

List A Element	List B Belongs to
i) hydrogen	a. group 1
ii) nitrogen	b. group 2
iii) oxygen	c. group 15
	d. group 16

12.43

	List A Compound		List B prepared by
i)	dihydrogen	a)	action of water on metals
ii)	dinitrogen	b)	heating ammonia with [illegible] oxide.
iii)	dioxygen	c)	Catalytic oxidation of ammonia.
		d)	thermal decomposition of $KClO_3$.

12.44

	List A Compound		List B Property
i)	$H_2SO_4(aq)$	a)	can be tested by ring test
ii)	$(NO_3)^-$	b)	is used as a bleaching agent for textiles, wood and paper pulp.
iii)	Hydrogen peroxide	c)	forms $H_2S_2O_8$ on electrolysis and on subsequent hydrolysis forms H_2O_2
iv)	Water	d)	looses hydrogen on heating
		e)	becomes hard because of dissolved Ca and Mg salts.

12.45

List A Property	List B Examples
i) amphoteric nature of water.	a) $2H_2O(l) + 2e \rightarrow 2(OH)^-(aq) + H_2(aq)$ $E^0 = -0.41$ V for $[OH^-] = 10^{-7}M$
ii) Oxidation reduction of water.	b) $BaCl_2 \cdot 2H_2O$
iii) hydrolysis	c) Al_2O_3
iv) oxidation of water	d) $O_2(g) + 4H^+(aq) + 4e \longrightarrow 2H_2O$
v) Water in interstitial site in crystal lattice	e) $H_2O(l) + H_2O(l) \rightarrow H_3O^+(aq) + OH^-(aq)$
	f) $SiCl_4(l) + 2H_2O(l) \longrightarrow SiO_2(s) + 4HCl(aq)$.

II. SHORT ANSWER TYPE ITEMS

12.46 Write the various conditions under which $H^+_{(g)}$, $H_{(g)}$ and $H^-_{(g)}$ species can be formed starting from dihydrogen.

12.47 How are the hydrides of platinum, palladium and nickel different from the alkali metal hydrides ?

12.48 What is the use of hydrogen in Vanaspathi manufacture?

12.49 Though the bond dissociation energy of dioxygen is high, how is a reaction such as combustion of charcoal sustain after being initiated by external heating?

12.50 Why is dioxygen unique among diatomic molecules ?

12.51 Why do you think deplition of the 'ozone layer' from the atmosphere will be harmful to plant and animal life ?

12.52 How can youexplain floatation of ice in liquid water ?

12.53 Why is H_2O_2 stored in coloured wax lined bottle in presence of a stabiliser ?

12.54 Why is it that normal boiling point of H_2O is known precisely, but that of H_2O_2 can only be estimated ?

12.55 Why is the dihedral angle of H_2O_2 115° in the gas phase, but reduces to 90.2° in crystal ?

12.56 How does H_2O_2 act both as an oxidant and a reductant ? Give appropriate examples to explain the reactions.

12.57 Hydrogen forms two oxides, H_2O and H_2O_2. Explain why hydrogen bonding is appreciable in H_2O, but it is not so in H_2O_2.

12.58 What is special about the structure of ozone molecules?

12.59 Give reasons for the fact that water is a liquid at room temperature while H_2S is a gas at the same temperature.

12.60 Explain why O-O bond distance in ozone is in between that of O_2 and H_2O_2.

12.61 Although most reactions of oxygen with metals and non-dmetals are exothermic, explain why, they all require initiation by heating.

12.62 Water is a good solvent for many metal salts and is thus useful in the biological system. Suggest:

a) reasons for its being a good solvent:

b) a method for complete removal of Cu^{++} and Mg^{++} ions from water;

c) a reason for the small but measurable electrical conductivity of water.

12.63 Give balanced chemical equation for the following processes:

a) oxidation of water to oxygen

b) amphoteric behaviour of water

c) hydrolysis of $AlCl_3$ to $Al_2O_3\ xH_2O$

d) hydrolysis of Na_2CO_3

12.64 Would you agree with the statement: "oxides of nitrogen produce a fascinating practure from the point of view of their varied staructure?"Support your answer with suitable examples.

12.65 Dinitrogen although inert and non-toxic is an important constituent of plant and animal kingdom. The oxides,which are formed in atmosphere are, of course toxic

a) Suggest a reason for inertness of dinitrogen.

b) How do nitrogen oxides reach the atmosphere and lead to the formation of acid rain?

c) Suggest a method for reducing nitrogen to ammonia.

III. LONG ANSWER TYPE ITEMS

12.66 Do you agree that the position of hydrogen in the periodic table is ambiguous ? Give reasons.

12.67 Discuss the importance of hydrogen bonding in water.

12.68 Why is water unique from the chemical point of view?

12.69 What are the various methods by which one can improve the lathering of soap in water?

12.70 Hydrogen peroxide can act as an oxidising as well as a reducing agent. Illustrate with suitable examples.

12.71 State and explain the action of dilute and concentrated nitric acid on copper and zinc.

12.72 Nitrogen is the first element of group 15 of the periodic table and forms a number of compounds under suitable conditions.

a) i) Write the electronic configuration of an isolated atom of nitrogen.

ii) Explain why the valency shall of nitrogen contains five electrons but it forms a maximum of four covalent bonds.

b) Consider HNO_3, NH_4^+ and N_2:

i) State the oxidation number of nitrogen in each'

ii) Show the electron dot structural formula of each'

iii) Describe in words and show by diagram the shape of each.

c) Describe briefly with an example each, giving reagents, reaction conditions and equations, how compounds containing nitrogen of the following oxidation number, could be conveniently prepared from nitric acid or a nitrate.

i) +2
ii) +3
iii) +4

d) State one use for each of the following and describe the property on which the use is based.

i) N_2
ii) HNO_3
iii) NH_3

IV. PROBLEM TYPE ITEMS

12.73 A substance X is crystalline in nature and is soluble in water.

a) The solution reacts with concentrated sulfuric acid in presence of copper turnings, with evolution of brown fumes.

b) When copper turnings are placed in solution X without an acid, the solution gradually turns blue and the turnings get coated with shining white particles.

c) When a well-cooled solution of X with concentrated sulfuric acid is carefully added to a freshly prepared solution of ferrous sulphate, a brown ring is obtained at the junction.

d) Name the substance X and describe the reaction involved in step c).

7/8

12.74 The element with electronic confirguration (He)$2s^2 2p^4$ exists in two allotropic modifiction. It forms a hydrate with hydrogen which is perhaps chemically the most important hydirde known. Name the elements the allotropes and the hydride.

12.75 The element with electronic configuration (Ne)$3S^2 3p^1$ form an oxide which dissolve both in acids and alkalies. Name the element, the oxide formed, its nature and the products of dissolution in HCl and NaOH.

UNIT - 13

CHEMISTRY OF NON-METALS - II

I OBJECTIVE TYPE ITEMS

(A) Multiple choice type : (Write the correct answer)

13.1 Which of the following pairs of elements is an example of "diagonal relationship" in the periodic table ?

a) Carbon silicon
b) Carbon boron
c) boron silicon
d) boron aluminium

13.2 Boron forms stable electron deficient compounds because :

a) it has three valence electrons and four valancee orbitals.
b) it is a non-metal.
c) it forms polymeric compounds easily
d) it has a small atomic size

13.3 Identify the incorrect statement regarding boric acid :

a) It has the trivial name of orthoboric acid.
b) It is a weak tribasic acid
c) It has a layer structure.
d) It has a high degree of hydrogen bonding in solid state.

13.4 **Boron** resembles carbon and silicon in many respects. However, one of the main differences of boron with carbon and silicon is that, boron

a) has a small size
b) has a high ionization energy
c) has a low electronegativity
d) compounds are Lewis acids.

13.5 Identify the statement that is not correct as far as structure of diborane is concerned :

a) There are two bridging hydrogen atoms in diborane.
b) Each boron atom forms four bonds in diborane
c) The hydrogen atoms are not in the same plane in diborane.
d) All B-H bonds in diborane are similar.

13.6 Which of the following statement regarding silicon is not correct ?

a) Silicon occurs in nature on a free element.
b) It dissolves hot aqueom alkali to liberate hydrogen.
c) The binary compound of silicon with carbon (SiC) is known as carborundum.
d) Elemental silicon has a diamond structure.

13.7 Carbon and silicon belong to the same group (Group 14) of the periodic table, and thus have certain similarities in property, e.g. :

a) Carbon and silicon each form multiple bonds easily with its ownself.

b) Both form double bonds with oxygen

c) Both form compounds such as AH_4 and AX_4 (where A is C or Si and X = halogens)

d) Both have gaseous dioxide.

13.8 Phosphorous burns in limited supply of air to form:

a) $P_2 O_3$

b) $P_4 O_6$

c) $P_2 O_5$

d) $P_4 O_{10}$

13.9 Which of the following is a mixed fertiliser?

a) potassium chloride

b) ammonium sulphate

c) urea

d) NPK

13.10 The key step in the Contact process is:

a) $S_8 + 8O_2 \longrightarrow 8 SO_2$

b) $2 SO_2 + O_2 \longrightarrow 2 SO_3$

b) $SO_3 + H_2 SO_4 \longrightarrow H_2 S_2 O_7$

d) $H_2 S_2 O_7 + H_2 O \longrightarrow 2 H_2 SO_4$

13.11 Which of the following has a planar structure ?

a) $[SO_4]^{2-}$

b) B_2H_6

c) BO_3 units

d) SiO_4^{4-}

13.12 Concentrated sulphuric acid has a charring action on carbohydrates because it :

a) acts as an oxidising agent
b) has strong affinity to water
c) has strong acidic property
d) is a diprotic acid.

13.13 Chemical reactions of H_2SO_4 are as a result of :

a) its strong acidic character
b) its strong affinity to water
c) its ability to act as an oxidising agent
d) all three (a, b, c,)given above.

13.14 The correct order of the increasing acidic strength is:

a) H Cl, H Br, HF, HI
b) H Br, H Cl, H I, H F
c) H F, H Cl, H Br, H I
d) H I, H F, H Cl, H Br.

13.15 Identify the noble gas used as a cryogenic agent for carrying out experiments at low temperatures:

a) helium
b) neon
c) argon
d) krypton

13.16 The gas most widely used in the discharge tubes for advertisements is :

a) helium
b) neon
c) krypton
d) kenon

B) Completion Type Items

Complete the following :

13.17 Boron belongs to group ____i)____ of the periodic table carbon comes _ ____ii)____ to boron in the periodic table, and silicon is located ____iii)____ to boron.

13.18 Boron hydrides are examples for electron -------- compounds.

13.19 Silicon polymers contain ____________ frame work.

13.20 From the equation,

$SiO_2 + 2C \rightarrow Si + 2CO$, we can infer that carbon is a better ---------- agent than silicon.

13.21 To enable glass to become more heat resistant ____________ is added to the batch.

13.22 The basic structural unit in silicates is the ____________ ion.

13.23 When Concentrated sulphuric acid turns, sugar black, due to ____________ ________.

13.24 Sodium thiosulphate is used as an antichlor in bleaching industry to remove excess of ________.

13.25 The binary compound of Si and C is known as ________ which is used as an abrasive and refractory material.

13.26 Radioactive element among the halogens is __________.

13.27 Because the halogens react readily by accepting an electron, they are all strong _________ agents.

13.28 Complete and balance the equations :

a) $H_3BO_3 \xrightarrow{heat}$ i)________ $\xrightarrow{heat}$ ii)________

b) $Si + 4(OH)^-$ ---- ------ $+ 2\ H_2$

c) ________ $+ 6\ SiO_2$ ------ $6\ CaSiO_3 + P_4O_{10}$

d) $P_4O_{10} + 6\ H_2O$ ---- ---------.

e) $4\ FeS_2 +$ ________---- $2\ Fe_2O_3 + 8SO_2$

f) $MnO_2 +$ i)________ ---- $MnCl_2 +$ ii)________ $+ 2\ H_2O$

c) True and False Type Items

Classify the following statements as true (T) and false (F) :

13.29 a) Silicon, phosphorous and sulphur being elements of the third period of the periodic table, have larger sizes and lower electronegativities than the first members of the respective groups.

b) Noble gases are totally inert

c) Boric acid (H_3BO_3) is a monobasic acid.

d) Being tetravalent, the simplest hydrinde of boron is BH_3.

e) Boron occurs in two isotpic forms but has no allotropes.

13.30 a) Silicon does not occur in nature as a free element but its abundance on the earth's crust is second only to oxygen.

b) Silicon polymers contain Si – O – Si framework.

c) High grade silicon required to make semiconductors is obtained by reduction of sand with coke in an electric furnace.

d) Rocks and weathered products viz. clays, soils, sands consist of almost entirely silicate minerals and silica.

e) Glass, as characteristic of solids has a definite melting point.

13.31 a) Red phosphorous and black phosphorous are the isotopes of phosphorous.

b) Superphosphate of lime is a mixed fertiliser.

c) Whereas nitrogen has numerous compounds in which it has sp or sp^2 hybridisation, these hybridisation states are not particularly stable for phorphorous.

d) Both phosphorous trioxide and phosphorous pentoxide are acidic oxides.

e) Two or more PO_4^{3-} units in acids of phosphorous join together to give condensed phosphate.

13.32 a) Sulphur has no allotropes.

b) Kipps apparatus is used in the laboratory for producing hydrogen sulphide.

H_2S finds extensive use in qualitative analysis, because the solubility of the sulphides can be controlled by H^+ in solution.

d) SO_2 is the anhydride of sulphuric acid

c) SO_3 is produced by the Contact process.

13.33 a) Positive oxidation states exist for all halogens.

b) All halogens under ordinary conditions are diatomic gases.

c) Monel metal used in the production of flourine, is an alloy of Ni-Cu-Fe.

d) In the interhalogen compounds XX_n (where n = 1, 3, 5 or 7, the smaller and more electronegative atom is assigned an oxidation state of -1.

e) HBr and HI are produced by treatment of bromides and iodides with concentrated H_2SO_4.

D) Matching type items:

Match the items in list A with the items in list B, by indicating the serial number of item of list A against that of list B.

13.34

List A. substance		List B. product on addition of water	
i)	P_4O_6	a)	$[B(OH)_4]^-$
ii)	P_4O_{10}	b)	H_2SO_4
iii)	$H_2S_2O_7$	c)	H_2SO_3
iv)	H_3BO_3	d)	H_3PO_3
		e)	H_3PO_4
		f)	HBO_2

13.35

List A

compound

i) Boric acid

ii) BO_3

iii) elemental silicon

iv) sulphate ion

v) S_8

vi) SO_2

List B

structure

a) tetrahedral

b) puckered ring

c) bent molecule

d) trigonal pyramid

e) diamond structure

f) planar

g) layer structure

13.36

List A

ions

i) Cl^-

ii) Br^-

iii) I^-

iv) S^{2-}

List B

colour of precipitate

a) black ppt with Cu^{2+} solution

b) blue with starch

c) white ppt with $AgNO_3$ solution

d) brown ppt with $AgNO_3$ solution

e) brown globule with Cl_2 water and CCl_4.

f) white ppt with starch.

13.37

List A		List B	
Noble gas		use/property	
i)	He	a)	flourscent bulbs
ii)	Ne	b)	flash bulbs
iii)	Ar	c)	as a diluent
iv)	Kr	d)	forms several compounds with F
v)	Xe	e)	filling balloons
vi)	Rn	f)	filling electric bulbs
		g)	radioactive

12.38

List A		List B	
Name of gas		formula	
i)	oleum	a)	$(S_2O_3)^{2-}$
ii)	thiosulphate	b)	$Na_2S_2O_3\ 5H_2O$
iii)	hypo	c)	$H_2S_2O_7$
		d)	SO_3

II. SHORT ANSWER TYPE ITEMS

13.39 Explain two reactions in which boron resembles silicon.

13.40 Give two characteristics to show that the chemistry of boron is different from that of other members of the same group.

13.41 Why is borone used as a water softener and a cleaning agent ?

13.42 Though the formula of boric acid is H_3BO_3, but it is a monobasic acid. Explain, with proper equations.

13.43 Write the Lewis dot structure of BF_3 molecule and justify the formation of coordinate covalent compounds by BF_3.

13.44 Draw the structure of orthoboric acid.

13.45 How has boron found use in the nuclear industry ?

13.46 What compounds are used for the production of ordinary soda glass ?

13.47 Write about the allotropes of phosphorous

13.48 How many series of salts are possible from orthophosphoric acid ? Name them.

13.49 What are condensed phosphates ?

13.50 Why is superphosphate of lime a good fertilisers ?

13.51 What is NPK mixture of fertilisers ? Name one compound in each category.

13.52 The moleuular formula of orthophosphorous acid is H_3PO_3. Can we represent it as $P(OH_3)$? Give reasons for your answer.

13.53 Why is it said that a nation's industrial strength can be guaged by the amount of sulphuric acid it produce and consumes ?

13.54 Explain why chlorine can replace bromine from bromides, while bromine cannot replace chlorine from chloride.

13.55 Give suitable examples with balanced equations wherever possible to illustrate the following properties, of H_2SO_4 : a) low volatility b) strong acidic character c) strong affinity to water d) ability to act as an oxidising agent.

13.56 Xe is oxidised by flourine to XeF_n , but not by chlorine. Account for this.

III LONG ANSWER TYPE ITEMS

13.57 What are the main uses of boron and its compounds.

13.58 Discuss the structure of diborane molecule

13.59 Mica, asbestos, feldspar and zeolites belong to the same family of compounds of an element.

a) Name the element
b) Name the basic structural unit in these compounds
c) State the various ways in which the basic structural units can combine.

13.60 Discuss the elemental forms of a) phosphorous, b) sulphur.

13.61 How do you effect the following conversations ?

a) red phosphorus from white phasphorus,
b) rhombic sulphur to plastic sulphur,
c) orthoboric acid to metaboric acid.

13.62 Starting from sulphur, explain the various steps involved in the preparation of sulphuric acid.

13.63 Explain the role of sulphuric acid

a) as a dehydrating agent
b) as an oxidising agent
c) in the fertilizer industry
d) as a laboratory reagent.

13.64 Sulphur is an element of group 16 of the periodic table and forms a number of compounds under suitable conditions.

a) (i) Write the electronic configurations of : its isolated atom, sulphur dioxide SO_2 and Sulphuric acid H_2SO_4.

(ii) State, the oxidation number of sulphur in each of the above compounds.

(iii) Write the structural formula for each of these compounds SO_2 and H_2SO_4.

(b) State one use each of the following and describe the property on which the use is based.

(i) SO_2 (ii) H_2SO_4 (iii) H_2S

(c) Why do you think sulphuric acid has a higher boiling point than what would be expected for a covalent compound of formula H_2SO_4 ?

13.65 Write the formulae of the compounds of chlorine with monovalent, bivalent, and trivalent elements. Predict the geometry of these on the basis of VSEPR theory.

13.66 How would you account for the following :

a) Fluorine forms no oxyacids

b) Isolation of fluorine is rather difficult.

c) Hydrogen fluoride has exceptionally high boiling point.

d) Among the interhalogens of XX_7 type, only IF_7 is known.

13.67 Among MF_4, MCl_4, MI_4 which one is :

a) the most volatile ?

b) the most difficult to decompose on heating ?

c) the easiest to hydrolyse in water ?

d) has the highest M-X bond energy ?

Give reasons for your answers in a), b), c), d) above.

13.68 Noble gases are no more referred to as inert gases. Justify the statement with two examples.

13.69 Name the compound which was prepared by Bartlett in 1962 and explain how the preparation of that compound led to the preparation of Xenon compounds.

13.70 How were the Noble gases discovered ? Why was their discovery taken to be a landmark in the development of the periodic table ?

IV PROBLEM SOLVING TYPE

13.71 On replacing one oxygen atom from an anion (A) by sulphur, another anion (B) is formed. B on oxidation with chlorine charges to the original ion A. Name the ion A and B.

13.72 The reactivity of halogens can be represented by :

$$\frac{1}{2} X_2 (g) + e^- \longrightarrow X^- (g).$$

Flourine inspite of its low electron affinity is more reactive than chlorine. Explain this on the basis of the given data :

F_F = 158 kJ mol^{-1}

I_{cl-cl} = 246 kJ mol^{-1}

EA (F) = 333 kJ mol^{-1}

EA (cl)= 349 kJ mol^{-1}

UNIT - 14

CHEMISTRY OF LIGHTER ELEMENTS

I. OBJECTIVE TYPE ITEMS

A) Multiple choice type(Write the correct answer)

14.1 Which of the following metals is amphoteric ?

a) K
b) Mg
c) Ca
d) Al

14.2 Which of the following metals occurs as oxide in nature:

a) Na
b) K
c) Al
d) Mg

14.3 The alkali metals can easily be detected by flame test, because they have :

a) low ionisation energy
b) low density
c) low electron affinity
d) high conductance

14.4 Sodium carbonate is :

a) a salt of a strong acid and a strong base
b) a salt of a strong acid and a weak base

c) a salt of a weak acid and a strong base,

d) a salt of a weak acid and a weak base,

e) not a salt at all.

14.5 For obtaining NaorK metal by electrolytic reduction of their chlorides in the Down's cell, $CaCl_2$ is added in the melt to :

a) make the molten salts better conductors

b) catalyse the process

c) reduce the melting points of the salts

d) decrease the reducing properties of the alkali metals

14.6 K burns in air to combine with oxygen to form :

a) K_2O

b) KO

c) K_2O_2

d) KO_2

14.7 The first ionisation energies of group 2 elements are higher than those of the corresponding group 1 elements because the alkaline earth metals

a) are denser

b) are harder

c) have higher melting points

d) are smaller in size.

14.8 Quick lime is :

- a) $CaCO_3$
- b) $Ca_3(Po_4)_2$
- c) CaO
- d) $CaSO_4\ 2H_2O$

14.9 Plaster of Paris is :

- a) anhydrous $CaSO_4$
- b) $(CaSO_4)_2\ H_2O$
- c) $(CaSO_4)_2\ 2H_2O$
- d) $CaSO_4\ 2H_2O$.

14.10 The element that does not belong to group 13 of the periodic table is

- a) boron
- b) aluminium
- c) rubidium
- d) gallcium

14.11 Magnesia cement is :

- a) a suspension of magnesium hydroxide in water
- b) crystalls of magnesium chloride hexahydrate
- c) a magnesium aluminium alloy
- d) a saturated solution of magnesium chloride mixed with magnesium oxide.

14.12 Aluminium is not attacked by :

a) oxygen

b) pure water

c) alkali

d) acids

(B) COMPLETION TYPE ITEMS

Complete the following :

14.13 Light metals are called so, because of their low

____

14.14 Sodium and potassium are generally obtained by ___i)___ reduction of their molten ___ii)_____ .

14.15 Na^+ is isoelectronic with _________ atom

14.16 The ionisation energy of sodium is ______ than that of potassium.

14.17 Sodium and potassium metals are extremely reactive and they are kept under ______ to prevent the metals from exposure to oxygen and moisture.

14.18 The compounds of alkali metals are readily soluble in water due to their_______ nature.

14.19 When sodium carbonate is hydrolysed in water, the resulting solution is ________ to litmus.

14.20 The first ionisation energies of group 2 elements are higher than those of the corresponding group 1 elements because, the atom of group 2 elements are _____i)____ in size and the electrons are more ____ii)____ bound.

14.21 The compound of magnesium used as a purgative is

____

14.22 Plaster of Paris is obtained by the partial dehydration of _______________

14.23 a) $2K + H_2O$ ------ $+ H_2$

b) $K + O2$ ----- -------.

c) $2\ Na + O_2$ ---- ---------.

d) $CaCO_3 + H_2O + CO_2$ ---- -------.

e) $2\ CaSO_4\ 2\ H_2O \xrightarrow{heat}$ -------- $+ 3H_2O$

f) $Al_2\ O_3 \cdot 2H_2O + 2H_2O + 2\ NaOH$ ---- ----- $+ 3H_2O$.

c) True and false type items

Classify the following statements as true (T) or false(F)

14.24 a) Sodium and potassium react vigorously with oxygen to form their perioxide.

b) Sodium is used to prepare antiknock agent for petrol

c) $CaCl_2$ and $MgCl_2$ are undesirable impurities in table salt, because they are deliquescent

d) Sodium hydrogen carbonate is used both as baking soda and as a mild antiseptic for skin infection

e) The fertiliser industry refers to any potassium salt as "potash".

14.25 a) CaO is also known as slaked lime.

b) Magnesium burns with evolution of more heat per mole than even hydrogen.

c) The sole product of burning of magnesium in air is magnesium oxide.

d) Limestone and **marble** are two forms of $CaCO_3$.

e) Magnesium and calcium are obtained in the metallic form by chemical reduction.

14.26 a) Aluminium is obtained by direct electrolysis of baxite.

b) Alums are double salts of aluminium sulphate with sulphates of other metals

c) Rice husk has been used in cement making because of its high silica content

d) All mammals have K^+ and Na^+ in red blood cells in the ratio of 7:1

e) The main pigment for the absorption of light in plants is chlorophyll which contains calcium

(D) Matching type items

Match the items in list A with the relevant items in list B indicating the serial number of item of list A against that of list B.

14.27

	List A ions		List B associated charge
i)	perioxide	a)	+1
ii)	bicarbonate	b)	+2
iii)	ammonium	c)	-1
iv)	phosphate	d)	-2
		e)	-3

14.28

List A	List B
element	present in
i) magnesium	a) bones
ii) silicon	b) red blood cell
iii) calcium	c) air
iv) potassium	d) chlorophyll
	e) rice husk

14.29

List A	List B
property	corresponding compound
i) double salt	a) $Al(OH)_3$
ii) dimer	b) $Pb(C_2H_5)_4$
iii) amphoteric	c) $MgCl_2$
iv) deliquescent	d) Al_2Cl_6
	e) $Na_2SO_4 \cdot Al_2(SO_4)_3 24H_2)$

14.30

List A	List B
compound	number of molecules of water of crystallisation associated with the compound
i) washing soda	a) $0.5H_2O$
ii) plaster of Paris	b) $2H_2O$
iii) gypsum	c) H_2O
iv) epsomite salt	d) $6H_2O$
v) sodium alum	e) $7H_2O$
	f) $10H_2O$
	g) $24H_2O$

14.31

	List A		List B
	metal		found in
i)	sodium	a)	bauxite
ii)	magnesium	b)	talc
iii)	calcium	c)	chalk
iv)	aluminium	d)	cinnaar
		e)	albite

14.32

	List A		List B
	compound		matching formula
i)	soda ash	a)	$CaSO_4 \ 2H_2O$
ii)	caustic soda	b)	Na_2CO_3
iii)	washing soda	c)	$NaOH$
iv)	baking soda	d)	$CaCO_3$
v)	gypsum	e)	$Na_2CO_3 \ 10H_2O$
		f)	$NaHCO_3$
		g)	$MgSO_4 \ 2H_2O$

14.33

	List A		List B
	metal		Property
i)	K	a)	reacts rigorously with oxygen to give its peroxide.
ii)	Na	b)	brick red colouration in bunsen flame.
iii)	Ca	c)	reacts with NaOH liberating H_2
iv)	aluminium	d)	dissolves in dilute acid to give blue solution
		e)	burns in air to combine with oxygen to give its superoxide.

II. SHORT ANSWER TYPE ITEMS

14.34 Why are the ionisation energies of alkali metals lowest when compared to elements of other groups ?

14.35 Name some of the mineral of magnesium and calcium.

14.36 Why does crude sodium chloride obtained from sea water become moist during rainy seasons, while pure common salt does not ?

14.37 Name the raw materials used and the by-product obtained in the Solvay process of manufacture of soda ash.

14.38 In the Solvay process of manufacture of Soda ash, why is it that only sodium hydrogen carbonate precipitates out and not the other compounds ?

14.39 What are the chemical formulae of caustic soda, washing soda & baking soda ? What are their main uses ?

14.40 Why is it that even though the melting points of sodium and potassium chlorides are high, alkali metals are obtained by electrolytic reduction of their molten chlorides ?

14.41 What is the other name of sodium hydrogen carbonate ? Why is it called by that name ? Write the appropriate reaction supporting your answer.

14.42 How do the ionisation energies of the alkaline earth metals compare with those of the alkali metals ?

14.43 Name the metals which are found in each of the following minerals.

a) saltpetre (b) marble (c) epsomite

d) bauxite.

14.44 What are the raw materials used in the manufacture of Portland cement?

14.45 Write the average composition of Portland cement.

14.46 How is quick lime prepared from marble ?

14.47 Starting from quick lime, how are slaked lime, milk of lime and lime water prepared ?

14.48 According to the electrochemical series, aluminium should be reactive, but actually it turns out to be quite unreactive why ?

14.49 Explain the structure of aluminium chloride.

III. LONG ANSWER TYPE ITEMS

14.50 (a) Describe in brief the manufacture of caustic soda using the Castner - Kellner cell.

(b) Draw a neat and labelled diagram of the cell.

(c) Why do you think that carbon anode is used in the process and not any metal like Cu, Fe or Pt?

(d) what changes are expected if solid NaOH is left exposed in air for a long time ?

14.51 What is the basic principle utilised in the manufacture of sodium carbonate by the Solvay process ? Discuss the process.

14.52 What is cement ? How is it manufactured ?

14.53 Why are sodium, potassium, magnesium and clacium important biologically ?

14.54 Discuss the Dow process for obtaining magnisum from sea water.

14.55 Compare the properties of the alkali metals and the alkaline earth metals.

14.56 Discuss the uses of aluminium and calcium relating each use to a particular property of the metal.

14.57 Bauxite is used for the extraction of aluminium on a large scale:

(a) Why it is necessary to purify bauxite before isolating aluminium ?

(b) Write in sequence the steps followed in obtaining pure aluminium from bauxite.

(c) What is the role of cryolite in the electrolytic cell for production of aluminium ?

(d) Write the equations involved during the whole process.

(e) Draw a neat and labelled diagram of the cell used.

UNIT - 15

CHEMISTRY OF HEAVIER METALS

I OBJECTIVE TYPE ITEMS

(A) Multiple choice : (Write the correct answer)

15.1 Which of the following elements belongs to group 14:

a) Fe

b) Hg

c) Zn

d) Pb

15.2 Slag in iron manufacture contain :

a) $CaCO_3$

b) CaO

c) $CaSiO_3$

d) SiO_2

15.3 Which is not a property of cast ion ?

a) It is hard

b) It is brittle

c) It can be welded by hammering

d) Molten cast iron expands slightly when solidified.

15.4 Extraction of iron from its ore consists of smelting and refining. Smelting is carried out in a :

a) Bessemer convertor
b) Open hearth convertor
c) Electric furnace
d) Blast furnace.

15.5 Hard steel can be further hardened by hheating it to red hot and then cooling it by plunging it into cold water. This process is called :

a) quenching
b) annealing
c) tempering
d)a smelting

15.6 Among the following which one is an alloy of iron :

a) bronze
b) gunmetal
c) type metal
d) invar

15.7 Which among the following is an ore of copper ?

a) haemetite
b) malachite
c) argentite
d) calamine

15.8 Which of the following pairs of elements is present in brass :

a) Al and Zn
b) Cu and Zn
c) Cu and Fe
d) Pb and Sn

15.9 A mixture of copper sulphate and lime, known as "Bordeaux mixture" is used :

a) as a fungicide in agriculture
b) in electroplating
c) in electric batteries
d) as a mordant in dyeing

15.10 "Hypo" used in photography is a solution of :

a) quinol in alkali
b) sodium thiosulphate
c) silver bromide
d) potassium cyanide.

15.11 Silver bromide is used for making film in photography because :

a) it is insoluble in nitric acid
b) it does not dissolve in excess ammonia

c) it is photosensitive

d) it is insoluble in sodium thiosulphate.

15.12 Though Zn and Hg belong to the same group, they differ in many of their propertis. The property that is shared by both is :

a) they form oxides readily

b) they react with steam readily

c) they react with hot concentrated H_2SO_4

d) they react with hot sodium hydroxide

15.13 Which of the following elements form compounds only in one oxidation state :

a) Fe

b) Cu

c) Zn

d) Ag

15.14 Which of the following is used on as ingredient in flouride toothpaste :

a) SnF_2

b) PbF_2

c) PbF_4

d) AgF

15.15 "Calomel" is :

a) K_2HgI_4

b) Hg_2Cl_2

c) $AgCl$

d) $HgCl_2$

15.16 (B) Completion type items

Complete the following :

15.16 a) Hardnessof steel depends on its _______ content and heat treatment.

b) The process by which brittleness of steel is removed retaining its hardness is called ______.

c) If steel is heated to temperature well below red heat and is then cooled slowly, the process is called _________.

d) Iron forms many compound in the oxidation states ___i)___ and ___ii)___

e) Extraction of iron from its ores consists of two stages : ___i)____ and __ii)___.

15.17 a) Silver can be obtained from the _______ obtained in the electrolytic refining of copper.

b) Nearly half of the total world production of gold is from the mines of _______.

c) Removal of silver and copper from gold is known as _________.

d) In purification of silver by the electrolytic method ___i)___ acts as the anode and ___ii)___ as the cathode.

e) Though copper is red-brown with high lustre, but the surface is often dulled by _______ formation.

15.18 a) An alkaline solution of K_2HgI_4 is called ______ .

b) Zinc reacts with hot sodium hydroxide solution to form soluble _________.

c) ________ is widely used to coat iron to resist corrosion.

d) Pb_3O_4 behaves as a mixture of ___i)___ and ___ii)___

e) Lead appears dull because it gets covered with a thin layer of _________ and __________.

C) True and False type items

Classify the following statements on true (T) and false (F) :

15.19 a) Cast iron is also known as pig iron

b) Wrought iron is obtained by refining cast iron

c) Addition of metals and carbon converts iron to steel.

d) There are three methods of obtaining iron from its ore : the Bessemer process, the open hearth process and the electric furnance process.

e) Hardness of steel depends on its carbon content and heat treatment.

15.20 a) In India silver is obtained directly from its ores.

b) Gold and silver are known as 'Noble metals' because of their weight.

c) Copper appears green because of a coating of CuO.

d) $2\,Cu^{+} \dashrightarrow Cu + Cu^{2+}$ represents a disproportionation reaction.

e) Aqua regia is 3 parts HNO_3 and 1 part HCl.

15.21 a) Sn (iv) and Pb (iv) oxides are amphoteric.

b) Zinc and mercury are both equally good conductors of heat and electricity.

c) Zinc is resistant to atmospheric corrosion on account of the formation of basic carbonate on its surface

d) Crude tin is remelted in an inclined furnace so that unfusible tin is left behind

e) Ordinary white tin is attacked by air or water at room temperature to form tin oxide SnO_2

15.22 a) $Fe_2O_3 + 3CO \rightarrow$ ------- $+ 3CO_2$

b) $Fe_2O_3 + CO$ ----- ------- $+ CO_2$

c) $2Ag_2S + 8CN^- + O_2 + 2H_2O \rightarrow$ ------- $+ 4OH^- + 2S$.

d) $2K\,Au(CN)_2 + Zn$ --- ---------- $+ 2Au$.

e) $Cu_2O + Cu_2S \rightarrow$ -------- SO_2

f) $2Au + 3Cl_2$ ---- ____i)____ heat ____ii)____ $+ Cl_2$

g) $Zn + 2(OH)^- + 2H_2O$ ----- -------- $+ H_2$

15.23 a) $Sn + Cl_2 \rightarrow$ ------------.

b) $Pb + Cl_2 \rightarrow$ ------------.

c) $Sn + HNO_3$ conc. ________ --------.

d) $Pb + HNO_3$ conc. ________ --------.

e) a $6PbO + O_2$ ----------.

(D) Matching type items

Match the items in list A with relevant items in list B by indicating the serial number of items of list A against that of list B.

15.24

	List A		List B
	name of alloy		used in manufacture of
i)	stainless steel	a)	safes
ii)	manganese steel	b)	gears
iii)	nickel steel	c)	high speed cutting tools
iv)	tungsten steel	d)	cutlery
		e)	ocean cables

15.25

	List A		List B
	name of compound		formula
i)	green vitriol	a)	$FeSO_4(NH_4)_2SO_4$ $6H_2O$
ii)	mohr salt	b)	$Fe_2(SO_4)_3$ $(NH_4)_2SO_4$ $24H_2O$
iii)	ferric alum	c)	$FeSO_4$ $7H_2O$
iv)	blue vitriol	d)	$Na_2S_2O_3$
v)	hypo	e)	$CuSo_4$, $5H_2O$
		f)	$ZnSO_4.7H_2O$

15.26

	List A		List B
	name of process		description of process
i)	annealing	a)	removal of copper and silver from gold ;
ii)	roasting	b)	heating a metal to a temperature well below red heat and then cooling slowly ;

iii)	tempering	c)	heating steel followed by slow cooling such that hardness is retained but brittleness disappears
iv)	parting	d)	heating in a limited supply of air.
v)	quenching	e)	removal of impurities as silicate ;
		f)	hardening a metal by heating to red heat followed by plunging it into cold water for cooling

15.27

	List A Metal		List B Use
i)	Cu	a)	for making electrical cables and appliances
ii)	Pb	b)	for making food containers
iii)	Zn	c)	for galvanising
iv)	Sn	d)	for making bullets and shots
v)	[illegible]	e)	preparation of calomel

II SHORT ANSWER TYPE ITEMS

15.28 What are the main differences between cast iron and wrought iron ?

15.29 What are the methods of production of steel on a large scale ?

15.30 Why is it that if cast iron contains appreciable level of phosphorous, the convertor is lined with CaO and MgO instead of SiO_2 and some lime is added to the molten cast iron ? Attempt to white the equations that will support your answer.

15.31 Why is $FeCl_3$ used by block makers ? Write the equation supporting your answer.

15.32 What is meant by "18 carat" gold ? What does the word "carat" signify ?

15.33 What is meant by the term "925 fine silver ?

15.34 State the electronic configuration of group 11 elements and suggest the possible oxidation states.

15.35 Why are alloys preferred over pure metals for certain uses ?

15.36 Which is that metal that is present in all of the following alloys : bronze, brass, gunmetal, constantan ?

15.37 When left open to the atmosphere, how does Cu, Ag and Au behave ?

15.38 Though the atoms of Cu, Ag and Au have one electron in the outermost shell like the atoms of alkali metals ; their properties are quite different. Give a precise reason for this difference.

15.39 What is meant by disproportanation reaction ? Give an example.

15.40 How is blue vitriol prepared ? What happens when it is heated ? Give appropriate reactions.

15.41 What is Bordeaux mixture ? What is this used for ?

15.42 Write reactions to support that ZnO is amphoteric.

15.43 What is Nessler's reagent ? How is it prepared ? What is it used for ? Give reactions wherever possible.

15.44 What is the best antidote for mercury poison ? How does it work ?

15.45 What is "calomel" ? Write two properties of calomel. What happen when it is heated ? Write the corresponding reaction, What is calomel used for ?

15.46 What is white vitriol ? How is it prepared ? What happens to it when heated ? Write the equation. What are its main uses ?

15.47 What are some of the important alloys of Zn ?

15.48 What is galena ? Write the equation involved in production of Pb from galena.

15.49 What role does $SnCl_2$ play in the volumetric estimation of Fe (III) ?

III LONG ANSWER TYPE ITEMS

15.50 What are the different ores of iron ? Where are they found in India ? Explain the production of cast iron from iron ore with the help of equations.

15.51 Discuss the different methods of steel production.

15.52
- a) How is anhydrous Fe_2Cl_6 prepared ?
- b) What happens when it is heated ?
- c) Comment on its solubility in water, ether and alcohol
- d) Mention two of its uses.
- e) Draw the structure of Fe_2Cl_6 and comment on the bondings involved.

15.53 Name two important ores of Ag and explain the role of sodium cyanide and metallic zinc in the extraction of silver from its ores. Name another metal which can be extracted in a similar manner. Give equations for both the cases.

15.54 Where in India does one find commercially viable deposits of copper ? How is copper extracted from copper pyrite ? Write equations wherever possible.

15.55 a) What is meant by the word "photography" ?

b) What is the basis of the process of photography ?

c) What are the various steps involved in obtaining a photograph ?

15.56 Though Zn and Hg belong to the same group, but their properties are quite different. Discuss these differences.

15.57 a) Given that the electronic configurations of tin and lead are (Kr) $4d^{10}\ 5s^2\ 5p^2$ and (xe) $5d^{10}\ 6s^2\ 6p^2$. Explain why they exhibit the oxidation states +2 and +4 in their compounds.

b) In +2 oxidation state, Sn is reducing in character. Write two chemical reactions that show the reducing behaviour of $SnCl_2$.

c) Write equations to show amphoteric character of SnO_2 and PbO_2.

d) What is the test for pb^{2+} in qualitative analysis ? Attempt to write the relevant equation.

IV PROBLEM SOLVING TYPE ITEMS

15.58 A metal reacts with bromine to form a bromide which is insoluble in dilute NH_4OH, but is soluble in sodium thiosulphate. The product is photosensitive and turns black on exposure to light. Name the metal and state the group of the periodic table to which the metal belongs.

15.59 An alloy contains three metals A, B and C of the same group of the periodic table. When treated with concentrated HNO_3, most of the alloy dissolves, leaving a residiue (R), After filteration and adding hydrochloric acid to the filtrate, a white precipitate (P) is obtained, which is filtered. To this filtrate when an excess of ammonium hydroxide is added, a dark blue solution (S) is obtained. Identify A,B,C,R,P and S.

UNIT 16

STRUCTURE AND SHAPE(S) OF HYDROCARBONS

I. OBJECTIVE TYPE ITEMS

(A) Multiple choice type (write the correct answer)

16.1 The number of π bonds in $N\equiv C-CH=CH-C=N$ are :

a) 5
b) 8
c) 4
d) 7

16.2 The general formula of an alkane is :

a) $C_n H_{2n}$
b) C_nH_{2n-2}
c) C_nH_{2n+2}
d) C_nH_{2n+4}

16.3 At room temperature the eclipsed and the staggered forms of ethane cannot be isolated because :

a) both the conformers are equally stable
b) they interconvert rapidly
c) there is a large energy barrier of rotation about the σ bond
d) the energy difference between the conformers is large

16.4 The number of secondary carbons in 2,2-dimethyl butane is:

a) 4
b) 0
c) 1
d) 2

16.5 The hydrocarbon having maximum ring strain is :

a) cyclopropane
b) cyclobutane
c) cyclopentane
d) cyclohexane

16.6 Amongst the following pairs the structural isomers are:

a) benzene, cyclohexane
b) 2,2-dimethylpropane, 2-methylbutane
c) n-petane, cyclopentane
d) 2-methylpentane, n-pentane

16.7 Which of the following has two π bonds ?

a) benzene
b) propene
c) propyne
d) m-xylene

16.8 Identify the correct statement regarding alkanes :

a) They have at least one C = C.
b) They have two less hydrogen than the corresponding a;kane.
c) They were earlier known paraffins
d) They have the general formula of C_nH_{2n}

16.9 Of the following pairs the one that has a pair of arene compounds is :

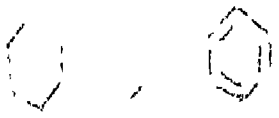
a) benzene, anthracene
b) anthracene, cyclohexane
c) benzene, 1,3-cyclohexadiene
d) naphthalene, cyclohexane

16.10 Of the following, the pair that represents stereoisomerism is :

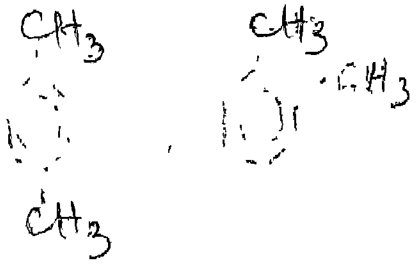
a) optical isomerism, structural isomerism;
b) geometrical isomerism, conformational isomerism;
c) optical isomerism, geometrical isomerism;
d) geometrical isomerism, structural isomerism.

16.11 Which pair of compounds represents isomeric arenes ?

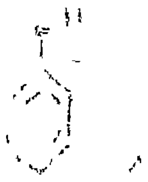
a)



b)

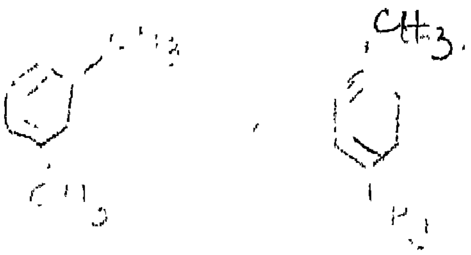


c)

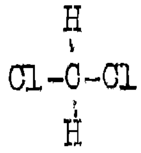


$CH_3(CH_2)_5-CH_3$

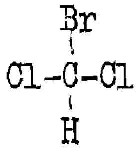
d)



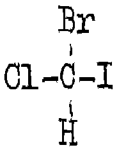
16.12 Which of the following would be optically active ?

a) 

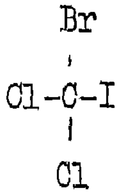
$$\begin{array}{c} H \\ | \\ Cl-C-Cl \\ | \\ H \end{array}$$

b) 

$$\begin{array}{c} Br \\ | \\ Cl-C-Cl \\ | \\ H \end{array}$$

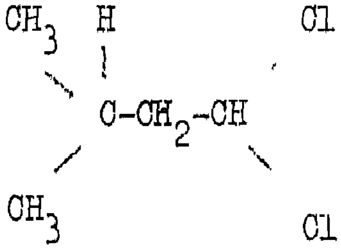
c) 

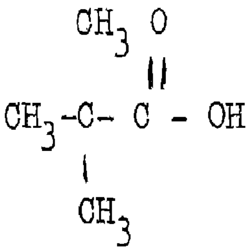
$$\begin{array}{c} Br \\ | \\ Cl-C-I \\ | \\ H \end{array}$$

d) 

$$\begin{array}{c} Br \\ | \\ Cl-C-I \\ | \\ Cl \end{array}$$

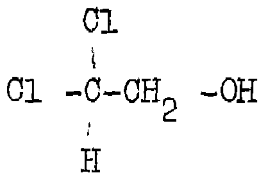
16.13 Which of the following will has a chiral carbon atom ?

a) 

b) 

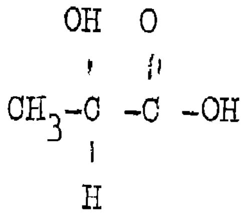
$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}-\overset{\displaystyle O}{\overset{\|}{C}}-OH$$

c)



$$Cl-\overset{Cl}{\underset{H}{C}}-CH_2-OH$$

d)



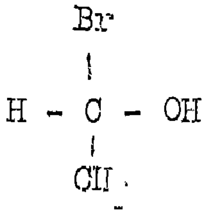
$$CH_3-\overset{OH}{\underset{H}{C}}-\overset{O}{\overset{\|}{C}}-OH$$

16.14 Which amongst the following would exhibit geometric isomerism ?

a) 2-butene
b) 1-butene
c) 1-butyne
d) 2-butyne

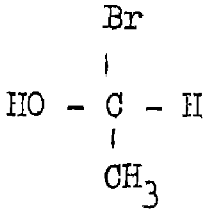
16.15 Which of the following pairs has a pair of enantiomers ?

a)



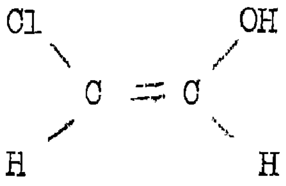
$$H-\overset{Br}{\underset{CH_3}{C}}-OH$$

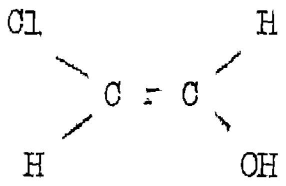
,



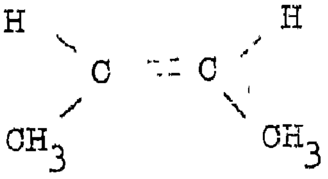
$$HO-\overset{Br}{\underset{CH_3}{C}}-H$$

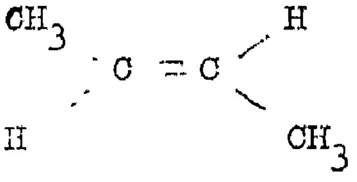
b)



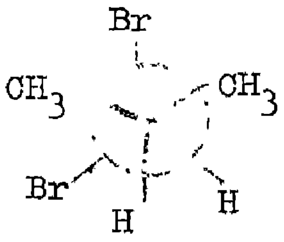


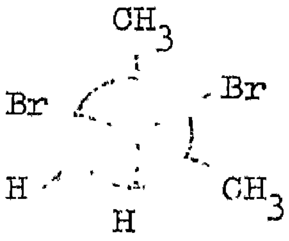
c)





d)



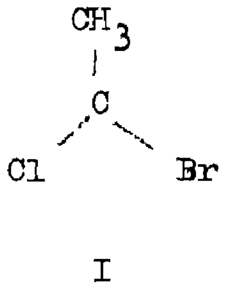


16.16 Which of the following is an arene ?

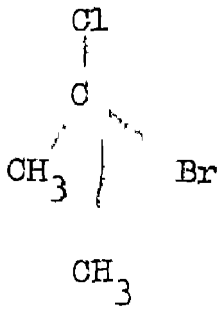
a) ethane
b) butane
c) hexane
d) benzene

16.17 Which of the following exhibits optical rotation ?

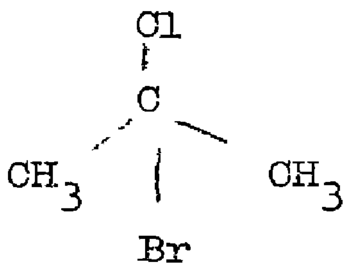
a)



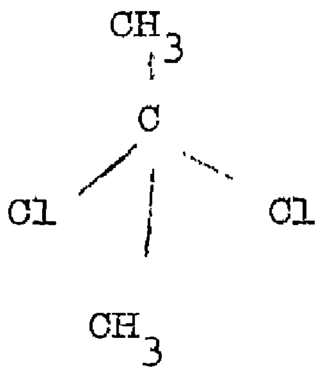
b)



c)



d)



16.18 Which of the following is an alkane ?

a) C_4H_{10}

b) C_3H_4

c) C_3H_{10}

d) C_6H_6

16.19 Which of the following is an alkyne ?

a) C_3H_8

b) C_5H_{10}

c) C_3H_6

d) C_3H_4

16.20 Which of the following has a carbon atom with sp^2 hybridisation ?

a) ethyne
b) ethene
c) ethane
d) propane

16.21 Identify the statement that is incorrect as far as optical isomerism is concerned.

a) Optical isomerism is a type of stereoisomerism,
b) Optical isomers have an assymetric carbon atom.
c) Even when conditions are achiral enantiomers display different chemical reactivity.
d) Enantiomers differ from one another in their behaviour towards plane polarised light.

16.22 The hybridisation of central carbon in 1,2-propadiene $(CH_2=\overset{*}{C}=CH_2)$ is

a) sp^3
b) sp^2
c) sp
d) None of the above

(B) Completion type items

Complete the following:

16.23 The asymmetric synthesis is accomplished under ____________ conditions.

16.24 The isomers obtained by free rotation along C-C bond are known as ____________.

16.25 If the four valencies of a carbon atom are satisfied with four different atoms/groups, the carbon atom is termed as __________.

16.26 Enantiomers cannot be __________ on each other.

16.27 The enantiomer which rotates the plane of polarised light to the right hand side is called __________.

16.28 Cis and trans isomers originate due to __________ rotation.

16.29 Due to delocalization of molecular orbitals, stability of a molecule __________.

16.30 A π bond which is spread over more than two carbon atoms is referred to as a __________ bond.

16.31 Chair form of cyclohexane is __________ stable than the boat form.

16.32 Staggered conformer of a molecule is __________ stable than the eclipsed conformer.

16.33 At room temperature, the eclipsed and the staggered form of ethane interconvert rapidly and cannot be __________ as separate conformers.

16.34 The first step in the visual process involves the conversion of one __________ isomer into another under the influence of light.

16.35 The process of separation of d- and l-enantiomers is known as __________.

16.36 A __________ mixture contains equal amounts of two enantiomers.

16.37 A ______________ is an instrument used for measuring optical rotation.

16.38 Monochromatic light on passing through a ___________ becomes plane polarized light.

16.39 Butane and 2-methyl propane are __________________.

16.40 Alkenes can be either cyclic or acyclic but arenes are always ______________ compounds.

16.41 Carbon-carbon double bond comprises of a ____i)______ bond and a ___ii)____ bond.

16.42 The number of σ bonds in ethyne are ______________.

16.43 A reaction in which one enantiomer is preferentially formed is known as ____________.

16.44 Arenes are cyclic compounds having alternate single and double bonds with __________ electrons in the delocalised π bond.

16.45 The number of isomers possible in monosubstituted benzene are _____i)_____ while in disubstituted benzene are ____ii)_____.

16.46 Monosubstituted naphthalene has __________ positional isomers.

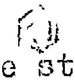
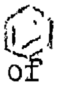
16.47 The bond energy of a C=C is ____________ than that of C-C single bond.

16.48 The bond energy of π bond is __________ than that of a σ bond.

16.49 A bond is formed by ______ i) ______ overlap of atomic orbitals while a π bond is formed by ______ ii) ______ overlap of atomic orbitals.

16.50 A sigma bond is ____________ along the internuclear axis.

16.51 Cyclobutane with a bond angle of ______ i) ______ is less strained than ______ ii) ______ having a bond angle of 60°.

16.52 The two structure of benzene  and  are called as ______ i) ______ but the true structure of benzene is in between these two and is known as ________________.

16.53 Benzene is less reactive than cyclohexane due to ________________.

16.54 The dissymmetry in carbon compounds was shown by the scientists ______ i) ______ and ______ ii) ______ .

(C) True and false type items

Classify the following statements as True (T) or False (F)

16.55 The factor responsible for optical rotation is the presence of a double bond.

16.56 When a compound contains an asymmetric carbon atom it exhibits optical rotation.

16.57 The shape of ethane molecule is linear.

16.58 Benzene molecule is a planar molecule.

16.59 The geometry of ethene molecule is tetrahedral.

16.60 p-dichlorobenzene and p-dimethylbenzene are positional isomers.

16.61 Staggered form is converted to the eclipsed form by supply of extra amount of enery.

16.62 Naphthalene, ethylene and xylene - all are aromatic in nature.

16.63 Benzene, o-xylene and naphthalene are planar molecules.

16.64 The asymmetric molecules that rotate the plane of polarized light to right hand side is termed as dextrorotatory.

16.65 The asymmetric molecules that rotate the plane of polarized light to left hand side are termed as dextrorotatory.

16.66 Enantiomers are not superimposable.

16.67 Ethyne is a linear molecule.

16.68 Chirality and nonsuperimposability represent the same phenomenon.

(D) Matching type items:

Match the items given in the list A with relevant answers given in list B, indicating the serial number of item in list A against that of list B.

16.69

	List A types of hydrocarbon		List B formula
i)	alkane	a)	C_4H_{10}
ii)	alkene	b)	C_3H_4
iii)	alkyne	c)	C_5H_{10}
		d)	C_6H_6

16.70

	List A name of compound		List B formula
i)	napthalene	a)	$C_{10}H_8$
ii)	ethyne	b)	$C_6H_4Cl_2$
iii)	1,2-dichlorobenzene	c)	C_2H_2
iv)	m-xylene	d)	C_8H_{18}
v)	1,2-dichlorohexane	e)	$C_5H_{12}Cl_2$
vi)	n-octane	f)	C_8H_{10}
		g)	C_6H_6

16.71

	List A name of compound		List B isomerism involved
i)	o-xylene and m-xylene	a)	functional isomerism
ii)	cis-2-butene and trans-2-butene	b)	positional isomerism
iii)	eclipsed and staggered form of ethane	c)	optical isomerism
		d)	geometrical isomerism
		e)	conformational isomerism

II. SHORT ANSWER TYPE ITEMS

16.72 What do you understand by the term delocalization of molecular orbital ? Explain using benzene as an example.

16.73 Give reasons for the fact that free rotation of C-C single bond is possible in ethane while in ethene there is restricted rotation along C=C.

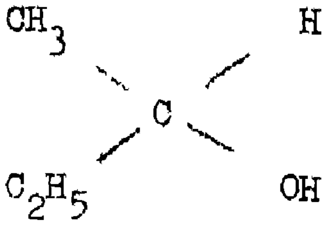
16.74 Draw the boat and the chair conformation of cyclohexane. Which of the two conformers is more stable ? Give reasons.

16.75 Draw the Nowman's projections for eclipsed and staggered conformers of ethane. Explain which of the two forms is more stable.

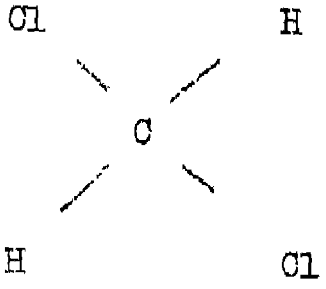
16.76 Describe the factors responsible for optical activity associated with compounds. Explain with two suitable examples.

16.77 Explain the term charality. Which of the following molecules is chiral ?

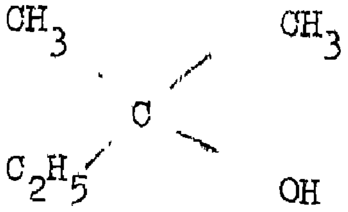
a)



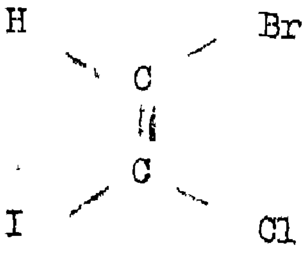
b)



c)

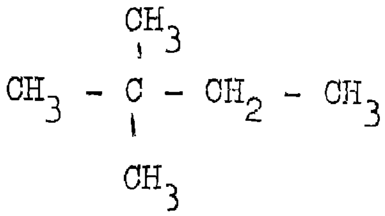


d)



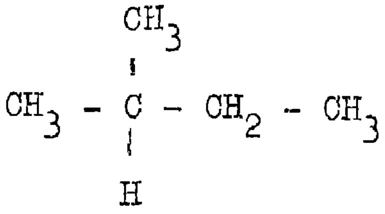
16.78 Label the primary (1°), secondary (2°), tertiary (3°) and quaternary (4°) carbon atoms in the following hydrocarbons.

a)



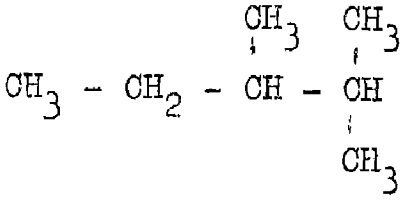
$CH_3 - \underset{CH_3}{\overset{CH_3}{C}} - CH_2 - CH_3$

b)



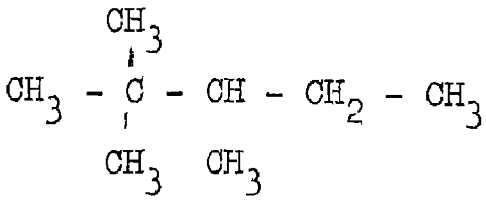
$CH_3 - \underset{H}{\overset{CH_3}{C}} - CH_2 - CH_3$

c)



$CH_3 - CH_2 - \overset{CH_3}{CH} - \underset{CH_3}{\overset{CH_3}{CH}}$

d)



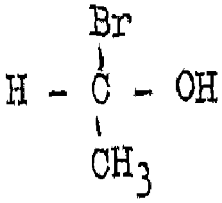
$CH_3 - \underset{CH_3}{\overset{CH_3}{C}} - \underset{CH_3}{CH} - CH_2 - CH_3$

e) $(CH_3)_4\ C$

16.79 Draw the Newman's projection formula of staggered form of 1,2-dichloreethane.

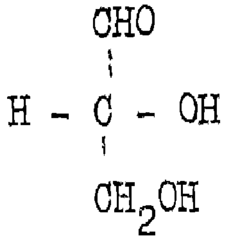
16.80 Draw the enantiometric forms of the given compounds.

a)



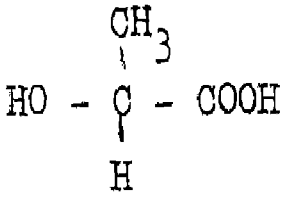
$$\begin{array}{c} \mathrm{Br} \\ | \\ \mathrm{H - C - OH} \\ | \\ \mathrm{CH_3} \end{array}$$

b)



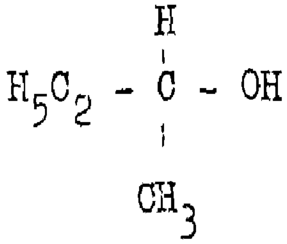
$$\begin{array}{c} \mathrm{CHO} \\ | \\ \mathrm{H - C - OH} \\ | \\ \mathrm{CH_2OH} \end{array}$$

c)



$$\begin{array}{c} \mathrm{CH_3} \\ | \\ \mathrm{HO - C - COOH} \\ | \\ \mathrm{H} \end{array}$$

d)

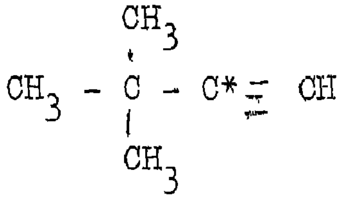


$$\begin{array}{c} \mathrm{H} \\ | \\ \mathrm{H_5C_2 - C - OH} \\ | \\ \mathrm{CH_3} \end{array}$$

16.81 Classify the following hydrocarbons into alkane, alkene and alkyne.

a) butene
b) ethyne
c) propene
d) propyne
e) hexane
f) butane
g) methane
h) pentyne
i) pentene

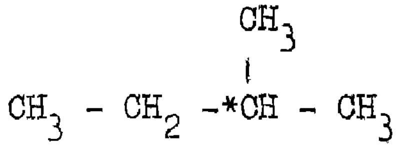
16.82 Classify the following hydrocarbons on the basis of hybridization state of the carbon atom marked with an asteric.

a) 

$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-C^*\equiv CH$$

b) $CH_3-\overset{*}{C}H=CH_2$

c) $CH_3-{}^*CH_2-CH_3$

d) 

$$CH_3-CH_2-{}^*\overset{CH_3}{C}H-CH_3$$

III. LONG ANSWER TYPE ITEMS

16.83 Discuss the structure of benzene.

16.84 Discuss the factors responsible for restriction of C=C bond rotation..

16.85 What do you mean by a 'chiral' carbon atom ? Discuss the optical rotation by molecules containing one chiral centre.

16.86 What is meant by resonance ? Illustrate your answer by taking examples of benzene and naphthalene.

16.87 Ethene molecule is planar, while ethyne molecule is linear. Discuss the structural difference on the basis of type of hybridization.

16.88 What are the distinguishing structural features of alkanes, alkenes and alkynes ?

UNIT 17

PREPARATION AND PROPERTIES OF HYDROCARBONS

I OBJECTIVE TYPE ITEMS

A Multiple choice type (write the correct answer).

17.1 Incomplete combustion can best be judged by :

a) measuring SO_2 in flue gases
b) excess oil in flue gases
c) measuring CO in flue gases
d) measuring CO_2 in flue gases

17.2 The octane number of a fuel gas containing 95% of n-heptane and 5% of 2,2,4-trimethyl pentane is

a) 95
b) 5
c) 90
d) 100

17.3 Iso-octane (2,2,4-trimethyl pentane) has an octane number of

a) zero
b) 50
c) 100
d) above 100

17.4 Which of the following has a zero octane number ?

a) petrol
b) iso-octane
c) LPG
d) n-heptane

17.5 Crude light oil consists of :

a) naphthalene and phenol
b) methyl and higher alkyls
c) anthracene and phenanthrene
d) benzene, toluene, xylene

17.6 Which of the following is used as jet engine fuel ?

a) kerosene
b) power alcohol
c) LPG
d) petrol

17.7 The pyrolysis of fuel or lubricating oil resulting in random cleavage of C–C bonds is called :

a) refining
b) cracking
c) reforming
d) knocking

17.8 Identify the incorrect statement regarding melting point of alkanes from the statements given below:

a) Variation in the melting point of the alkanes is not regular.
b) Variation of melting point of normal alkane plotted against number of carbon atoms in a chain gives a sawtooth pattern.
c) Molecules with odd number of carbon atoms have higher melting points than those with even number of carbon atoms.
d) Molecules with odd number of carbon atoms have lower melting points than those with even number of carbon atoms.

17.9 Main constituent of LPG is :

a) benzene
b) propane
c) methane
d) ethane

17.10 Alchols form alkenes by the process of :

a) dehydration
b) dehydrohalogenation
c) decarboxylation
d) halogenation

17.11 Treatment of ethene with ozone followed by treatment with zinc and water, leads to formation of

a) a diketone
b) an ozonide
c) formaldehyde
d) a diol

17.12 For hydrogenation of one mole of propyne, the quantity of hydrogen required is :

a) one mole
b) two moles
c) three moles
d) less than one mole

17.13 Addition of bromine to benzene is difficult due to its

a) higher molecular mass
b) close ring structure
c) resonance stability
d) presence of more than one double bond

17.14 Identify the incorrect statement regarding the octane numbers,. from the statements given below:

a) The quality of a fuel is indicated in terms of its octane number.
b) There is an arbitrary scale for octane numbers.
c) Iso-octane has been given the octane number of o.
d) Branched chain alkanes have high octane numbers.

17.15 A compound was shaken with bromine in tetrachloromethane (carbon tetrachloride). There was immediate decolourization of the red bromine solution. Choose the formula of the compound from the following :

a) $CH_3CH_2CH_2OH$

b) $CH_3CH_2CH_2CH_2CH_3$

c) $CH_3CH_2CH_2COOH$

d) $CH_2{=}CH\ CH_2CH_3$

17.16 A sample of crude oil was heated and its vapour passed on red hot pumice stone. A mixture of gas was evolved, which decolourised bromine in tetrachloromethane (carbon tetrachloride) :

a) The process taking place when the vapour from the crude oil passes over the heated pumice stone

- i) polymerisation
- ii) distillation
- iii) cracking
- iv) refining

b) The type of compound causing decolourisation of the bromine solution is:

- i) an alkane
- ii) an alkene
- iii) an alcohol
- iv) an acid

B Completion type items:

Complete the following

17.17 a) $HC=CH + 2H_2 \xrightarrow[\text{or Pd}]{\text{Ni or Pt}}$ ----------.

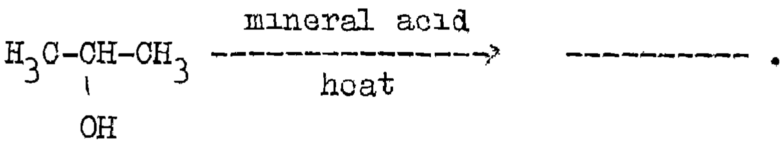
b) $CH_3-CH_2Br + Mg \xrightarrow[\text{ethes}]{\text{diethyl}}$ ----------.

c) $2C_2H_5I + 2Na \xrightarrow{\text{diethyl ether}}$ -------- + 2NaI.

d) $C_2H_5Br + H_2 \xrightarrow{\text{Pt or Pd}}$ --------- + HBr.

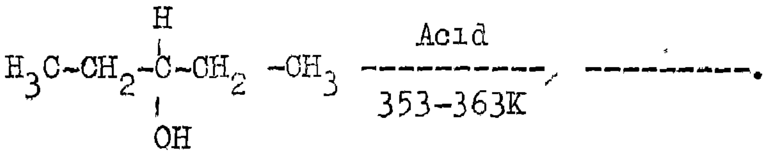
e) $CH_3COOH \xrightarrow[\text{ratio of 3:1, 630K}]{\text{NaOH and CaO in the}}$ --------- + Na_2CO_3.

17.18 a)



$H_3C-\underset{OH}{CH}-CH_3 \xrightarrow[\text{heat}]{\text{mineral acid}}$ ---------- .

b)



$H_3C-CH_2-\underset{OH}{\overset{H}{C}}-CH_2-CH_3 \xrightarrow[353-363K]{\text{Acid}}$ ---------.

c) $HC=CH + HBr \longrightarrow$ ---i)--- $\xrightarrow{HBr}$ ---ii)---.

d) $CH_3CH = CH_2 + H_2O \xrightarrow{H_2SO_4}$ ---i)--- + ---ii)--- .

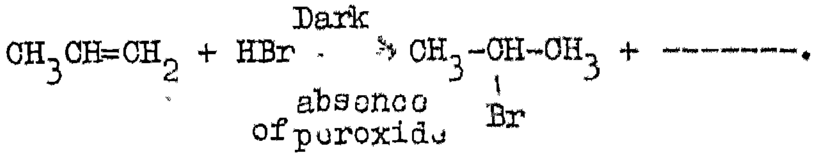
e) $CH_3CH_2CH=CH-CH_3 + KMnO_4 \xrightarrow{373-383K}$ ----- $+CH_3COOH+MnO_2$

17.19 a) 2-hexyne $\xrightarrow{\text{ozonolysis}}$ ————.

b) 1-bromobutane + alc. KOH $\xrightarrow{353-363K}$ ————$+KBr+H_2O$.

c) Acetylene + H_2O $\xrightarrow{Hg^{2+}}$ ———— ————→ ~~CH_3CHO~~———.

d) $H_3C-CH=CH-CH_3 + KMnO_4 + H_2O \xrightarrow{298-303K}$ ————$+MnO_2+KOH$

e)


$CH_3CH=CH_2 + HBr \xrightarrow[\text{absence of peroxide}]{\text{Dark}} CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3 +$ ————.

17.20 a) Propanol on ______________ gives propene.

b) Compared to organic acid, hydrocarbon are very ___________ acidic.

c) Alkanes cannot undergo _________ reactions.

d) in alkenes and alkynes the electrophile adds across the ______________ bond.

e) Due to the extra _________ of the delocalised electrons in benzene, it undergoes addition reaction under more drastic condition than do alkene and alkyne.

C **True and false type items:**

Classify the following statements as true (T) or false(F).

17.21 a) Charcoal and coke are impure forms of carbon.

b) The knocking property of gasoline is expressed in Cetane number.

c) The van der Waals forces are lesser in straight chain molecules than in branched chain molecules.

d) The boiling points of alkanes, alkenes and alkynes increase with increase in their chain length.

e) Cis-2-butene has a lower melting point than trans-2-butene.

17.22 a) The volatile material consisting of coal gas, ammonia and viscous liquid is known as pitch.

b) Ammonia is removed from coal by absorbing it in acid.

c) Coke is used as a reducing agent in metallurgy and as a fuel.

d) The higher boiling fraction of petroleum condenses in the lower portion of the bubble tower.

e) In cracking, larger molecules are broken down into smaller molecules, and in reforming straight chain alkanes are converted to arenes.

17.23 a) When propyl bromide is heated with alcoholic KOH, the resultant compound would be propylene.

b) Geometric isomerism does not affect the melting points.

c) The trade name of benzene hexachloride is gammaxene.

d) Teflon is a polymer.

e) The replacement of hydrogen atom of benzene by the SO_4^{2-} group is called sulphonation.

17.24 a) Coal and crude oil both are made up largely of arenes.

b) Coal on pyrolysis yields volatile compounds and coke.

c) Cracking is a random cleavage of C-C bonds.

d) Fuels resembling those obtained from petroleum can also be produced from coal.

e) Branched chain alkanes, alkenes and aromatic hydrocarbons have high octane numbers.

Matching type items:

(D) MATCHING TYPE

Match the items in List A with relevant answers given in list B by indicating the serial number of items of list A against those of list B.

17.25

	LIST A Fractions of petroleum		LIST B Uses
a)	gaseous	i)	candles, waterproofing fabrics
b)	kerosene	ii)	gaseous fuel, production of carbon black, gasoline.
c)	petroleum ether (ligroin).	iii)	solvent used in drycleaning of clothes
d)	gas oil, fuel oil and diesel oil	iv)	illuminant fuel, jet engine fuel
e)	paraffin (wax)	v)	furnace fuel, fuel for diesel engines in cracking
		vi)	motor fuel.

17.26

	LIST A hydrocarbons		LIST B characteristics
a)	butyne-1	i)	low reactivity
b)	n-butane	ii)	high polarity
c)	benzene	iii)	delocalised
		iv)	acidic character

17.27

	LIST A halogenation reaction		LIST B product
a)	benzene + $Cl_2 \xrightarrow{h\lambda}$	i)	chlorobenzene
b)	benzene + $Cl_2 \xrightarrow{AlCl_3}$	ii)	no reaction
		iii)	benzene hexachloride

II SHORT ANSWER TYPE ITEMS

17.28 What are the natural sources of hydrocarbons ?

17.29 What is coal ?

17.30 What is petroleum ?

17.31 Compare the composition of coal and petroleum.

17.32 Explain the origin of coal.

17.33 Explain the origin of petroleum.

17,34 How is coal classified on the basis of its carbon content ?

17.34 Name the various useful products obtained from petroleum refining.

17.36 Explain the term knocking.

17.37 What is the relation between structure of a hydrocarbon and knocking ?

17.38 What is the property that makes petrol, kerosene and diesel good fuels ?

17.39 Give a scale for measuring the quality of gasoline.

17.40 What is meant by the term "octane number" ?

17.41 What are the different methods used to improve the quality of a fuel used in gasoline engine ?

17.42 How can you obtain aliphatic hydrocarbons from coal ?

17.43 What is straight run gasoline and how is it obtained from crude oil ?

17.44 Why does the boiling point of hydrocarbons decrease with increase in branching ?

17.45 How can you account for the fact that, unsaturated compounds undergo addition reactions ?

17.46 Arrange the following compounds according to the increasing order of boiling points :

hexane, heptane, 2-methyl pentane, 2,2-dimethyl pentane.

Give reasons in support of your answer.

17.47 A common method of preparation of alkenes from alcohols involves heating of the alcohol with a mineral acid. What is the role of mineral acid in this preparation ?

17.48 To prepare homologues of ethyne, the first step is to treat it with sodium amide. Could the homologues of ethene be also prepared in the same manner ? Give reasons to sypport your answer.

17.49 What is the structural relationship between 3,3-dichlorohex-3-ene and 3,4-dichlorohex-3-ene ?

17.50 On converting benzene to toluene, state whether there will be a rise or fall in the melting point.

17.51 What happens when $H_3C(CH_2)_2HC=CHCH_2CH_3$ is i) treated with cold dilute $KMNO_4$ (ii) heated with $KMNO_4$. Write the appropriate equations.

17.52 What are the products obtained on hydration of 2-methyl butene-2 ? What is the major product ?

17.53 In $H_3C-HC=CH_2$ how does the addition of HBr differ from the addition of Br_2 molecule ?

17.54 Although benzene is an unsaturated compound, why does it still preferably undergo substitution reaction ?

17.55 Arrange the following in the increasing order of acidity:

$CH_3C=CH$, $H_3CCH_2CH_3$, $H_3C-HC=CH_2$.

Give reasons for your choice.

17.56 What test will you carry out to differentiate between 1-butyne and 2-butyne ?

17.57 A packet containing carbide of calcium fell into a bucket of water. A pungent smell is spread around. Write the chemical reaction which must have occured in the bucket of water.

17.58 Many a times vegetable oils develop unpleasant odour on long standing. Give the probable reason for this.

17.59 How can pure ethane be obtained from a sample contaminated with ethyne ?

17.60 Define the terms : (a) monomer (b) polymer (c) polymerisation.

17.61 Give the names of monomers which are used for the synthesis of polyethene, polyvinyl chloride, polystyrene and polytetrafluoroethene.

17.62 Give the uses of polyethene (PE) polyvinyl chloride (PVC), polystyrene (PS) and polytetrafluroethene (TEFLON).

17.63 Give the advantages and disadvantages of polymeric materials over the low molecular weight materials.

17.64 What is the role of red phosphorus in reduction of alkyl halides using hydroiodic acid ?

17.65 How is kerosene and gasoline obtained from petroleum ? Explain the process.

17.66 A gas decolourises bromine water and gives $CH_2=CHBr$ and CH_3CHBr_2 on treatment with one or two moles of HBr respectively. Identify the gas and explain the reaction.

17.67 Suggest a method for preparing butyne-2 from calcium carbide.

17.68 The ozonolysis of an organic compound gave acetone as the only product. Identify the compound.

III LONG ANSWER TYPE ITEMS

17.69 What is the Friedal Crafts reaction ? How can you convert benzene into acetyl benzene by using this method ?

17.70 Discuss the variation in boiling points, melting points, density and solubility of alkanes with their molecular structure.

17.71 How can you obtain alkanes from (i) unsaturated hydrocarbons (ii) alkyl halides (iii) carboxylic acids ?

17.72 Give the important chemical properties of alkanes.

17.73 How are alkenes prepared in the laboratory ?

17.74 You are given three jars containing ethane, ethylene and acetylene respectively. How will you identify each by chemical tests ?

17.75 Although both benzene and ethene are double bonded, how does unsaturation in benzene differ from the unsaturation in ethene ? Support your answer with reactions of these with hydrogen and bromine respectively.

17.76 Taking propene as an example, discuss the various types of addition reactions that can take place.

17.77 How are organic reactions classified ? Discuss giving suitable examples.

17.78 Describe the various types of exidising agents for alkenes. What are the products obtained during oxidation reaction ?

17.79 What is Markownikoff's rule ?

17.80 How are aromatic and aliphatic hydrocarbons obtained from coal ?

17.81 Explain the process of pyrolysis. Discuss with reference to coal.

17.82 Describe briefly the various additives and their functions in gasoline. What are the pollution problems associated with gasoline engines ?

17.83 Explain the following processess :

(a) cracking (b) refining

17.84 Describe two methods by which petroleum can be obtained from coal.

IV NUMERICAL PROBLEMS:

17.85 A sample of coal was found to have the following percentage composition. C = 75%, H = 5.2%, O = 12.8%, S = 1.2%, N_2 = 3.7%, Ash = 2.1%. Calculate the minimum amount of air necessary for complete combustion of 1 kg of coal. (You have been given that air contains 21% of oxygen by volume ; and mass percentage of oxygen is 23%).

17.86 What will be the octane number of a fuel which corresponds to mixture of 50% n-heptane and 50% iso-octane?

17.87 Calculate the weight and volume of air required for the combustion of 1 kg of carbon. (Given, air contains 21% of oxygen by volume.)

UNIT 18

PURIFICATION AND CHARACTERISATION OF ORGANIC COMPOUNDS

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice Type (Write the correct answer)

18.1 Sugar and common salt in a mixture, can be separated through the process of :

a) sublimation
b) distillation
c) crystallisation from a solution in ethanol.
d) chromatography

18.2 Benzoic acid and naphthalene in a mixture can be separated by treating the mixture with :

a) ethanol
b) hot water
c) cold water
d) ether

18.3 Which of the following can be used as a suitable adsorbent in the process of coluumn chromatography ?

a) glass beads
b) alumina
c) boron trifluoride
d) a mixture of inert gases

18.4 An impure sample of camphor, contaminated with sand can be purified by :

- a) distillation
- b) sublimation
- c) steam distillation
- d) none of the above

18.5 The gas liberated in Kjeldhal's method is :

- a) nitrogen
- b) ammonia
- c) nitrous oxide
- d) carbon dioxide

18.6 The value of 'x' in an organic compound with molecular formula C_xH_{12} with vapour density 42 is :

- a) 03
- b) 06
- c) 04
- d) 08

18.7 Lassaigna's test is performed on organic compounds to detect :

- a) carbon
- b) hydrogen
- c) nitrogen
- d) phosphorous

18.8 In Duma's method the volume of gas collected is equivalent to

a) ammonia
b) carbon dioxide
c) nitrogen
d) nitrous oxide

18.9 The molecular formula of an organic compound with a molecular weight of 78 and emperical formula of CH is :

a) C_6H_6
b) C_8H_8
c) C_4H_4
d) C_3H_3

18.10 The stationary and mobile phases in paper chromatography are :

a) liquid/liquid
b) solid/liquid
c) liquid/solid
d) liquid/gas

18.11 Identify the incorrect statement regarding crystallisation, from the following:

a) Crystallisation is an important procedure for purifying solids.

b) In crystallisation method, the solid is dissolved in a solvent in which it is soluble at all temperatures.

c) The impurities are removed by filtering the solution.

d) Crystals are separated by filtration.

18.12 Identify the incorrect statement regarding fractional distillation, from the following:

a) Fractional distillation is carried out if the boiling points of the liquids to be separated are close to each other.

b) Vapours go up from the distillation flask through the column.

c) The lower portion of the column is the cooler portion.

d) More volatile components condense in the upper part of the column.

(B) - Completion type items :

Complete the following :

18.13 a) $(CH_3COO)_2 Pb + Na_2S \xrightarrow{H^+}$ -------- + --------

b) $Na_2S + Na_2 Fe(CN)_5 NO \longrightarrow$ -------- .

c) $Fe^{3+} + 3NaSCN \longrightarrow$ -------- + --------

d) $NaCl + AgNO_3 \longrightarrow$ -------- + --------

18.14 a) Lassaigne's solution on treating with sodium nitroprusside gives a violet colour indicating the presence of __________. __________

b) A blood red colouration obtained when $FeSO_4$ is added to the fusion filtrate and heated in Lassaigne's test indicates the presence of ___i)___ and ___ii)___ in the organic compound.

c) This colour in reaction (b) above, is produced due to the formation of __________.

d) Phosphorus is detected by fusing the organic compound with __________ followed by extraction with water.

e) A Lassaigne's solution ~~xx~~ is boiled with dil. HNO_3, cooled and $AgNO_3$ is added. It gives a yellowish precipitate, sparingly soluble in ammonia. This indicates the presence of __________ in the organic compound.

18.15 a) An organic compound containing phosphorus on heating with fuming nitric acid followed by a treatment with magnesia mixture gives a precipitate of ___(i)___.

b) An organic compound containing nitrogen on heating with cupric oxide in an atmosphere of carbon dioxide sets free __________ gas.

c) An organic compound containing nitrogen on heating with H_2SO_4 gives ___(i)___ , which on treatment with excess of sodium hydroxide liberates ___(ii)___ .

d) An organic compound on heating in a current of oxygen(free from carbon dioxide) in presence of cupric oxide gives ___(i)___ and ___(ii)___ .

18.16 a) The molecular mass of a volatile organic compound is determined by the ________ method.

b) The molecular mass of organic acids is determined by the ________ method.

c) The molecular mass of a non-volatile organic compound is determined either by the ___(i)___ method or by the ___(ii)___ method.

d) The simplest formula that shows the ratio of the atoms of various elements present in a molecule is called the ________ .

18.17 a) The ________ of a organic compound is determined by mass spectrometry.

b) The functional groups present in an organic compound are determined by ___i)___ and ___ii)___ spectroscopy.

18.18 a) The gas displaced in Victor Meyer's method is ____________.

b) The gas estimated in Duma's method is ________.

c) The gas estimated in Kjeldhal's method is ____.

d) The gas estimated for determining percentage of hydrogen in an organic compound is _______ .

18.19 An organic compound containing non-volatile impurities can be purified by steam distillation if it is ___(i)___ and ___(ii)___ in water.

18.20 High boiling organic liquids which decompose at their boiling point can be purified by distillation under

__________ .

18.21 In steam distillation an organic substance vapourises at ________ temperature than its normal boiling point.

(c) Matching type items:

Match the items in list A with relevant answers given in list B by indicating the serial number of items of list A against those of list B.

18.22

	LIST A property to be determined		LIST B method used for determination
i)	molecular mass of benzene	a)	volumetric method
ii)	molecular mass of benzoic acid	b)	Victor Meyer's method
iii)	percentage of element in gammexene	c)	depression of freezing point method
iv)	percentage of element in aniline	d)	Kjeldahl's method
		e)	chromatographic method
		f)	Carius method

18.23

	LIST A method used		LIST B property determined
i)	mass spectrometry	a)	three dimensional structure
ii)	infrared spectrometry	b)	functional group
iii)	x-ray diffraction	c)	colour of the compound
		d)	molecular mass
		e)	type of protons

II SHORT ANSWER TYPE ITEMS

18.24 What are the different steps employed in studying the characteristins of organic compound?

18.25 Which method is most appropriate in the separation of the following mixtures ?

(a) sugar and common salt ;

(b) ether and toluene ;

(c) benzoic acid and naphthalene ;

(d) petroleum into various useful fractions.

18.26 Is it possible to get pure benzoic acid from a mixture of benzoic acid and naphthalene through the process of crystallisation using benzene as a solvent ? Give reasons.

18.27 What are the essential conditions for boiling of a liquid ?

18.28 Why are melting points and refractive index used as criteria of purity of organic compounds ?

18.29 If fusion of an organic compound with sodium is not performed, can we test the presence of nitrogen, sulphur and halogons in organic compounds by using the standard tests? If not why not?

18.30 Give the chemistry of Lassaigne's test.

18.31 Give the names of various types of chromatographic techniques.

18.32 With the help of two examples show the importance of choosing the correct solvent in crystallisation process.

18.33 How are high boiling liquids, or liquids which decompose at or below their normal boiling points distilled ?

18.34 What is steam distillation ? When is this method used?

18.35 What is the basic principle of chromatography ?

18.36 Explain why Lassaigne's solution is boiled with dilute HNO_3 before testing for halogens.

III LONG ANSWER TYPE ITEMS

18.37 What is the principle of steam distillation for the purification of organic compounds ? With the help of diagramatic representation describe the method of steam distillation.

18.38 Describe the most appropriate method applied for the purification of liquids, which decompose at or below their normal boiling points. Give an illustrative diagram also.

18.39 How will you detect the presence of nitrogen, sulphur and halogens in organic compounds ? Explain with the help of chemical reactions involved.

18.40 Describe the method of column chromatography by giving its principle, procedure and diagramatic representation.

18.41 Describe Kjeldahl's method for the estimation of nitrogen, in an organic compound. Give a neat and labelled diagram.

18.42 In order to determine the molecular mass of benzene, which method would you use ? Give reasons in support of your choice of the method. Give a diagramatic representation of the apparatus.

18.43 List the different methods employed for determination of molecular mass of different types of organic compounds. How do the selection of these methods depend upon the nature of the organic compounds ?

18.44 What are the common methods of separating organic compounds ? Explain each method with the help of a suitable example each.

18.45 How would you quantitatively determine the presence of carbon, hydrogen, sulphur, oxygen [illegible] an organic compound ? Explain with the help of calculations for each method.

18.46 Give details for methods used for the determination of molecular mass of any organic acid. Is this method applicable for the determination of molecular mass of organic bases ? What do you understand by the term "acidity of a base" and "basicity of an acid"?

18.47 The molecular formula of an organic compound was found to be CH_3N_2SCl. Give a diagrammatic representation of the procedure which would have been followed for arriving at this conclusion. Mention the steps involved in a systematic way (Details of the method are not required).

IV NUMERICAL PROBLEMS

18.48 An organic compound contains 69% carbon, 4.8% hydrogen and the remainder is oxygen. Calculate the mass of carbon dioxide and the weight of water produced when 0.2 g of this substance is subjected to complete combustion.

18.49 Calculate the amount of calcium carbonate formed when carbon dioxide produced by complete combustion of 94 g of phenol (C_6H_5OH) is passed through lime water. (at. wt. of calcium is 40).

18.50 An organic compound has only one bromine atom in its molecule. 1.57 g of the compound gave 1.88 g of silver bromide in Carius method. Find the molecular mass of the compound (at. wt. of Ag=108 and Br=80).

18.51 Calculate the amount of thiourea (H_2NCSNH_2) which is expected to give 23.3 g of barium sulphate in Carius method of sulphur determination (at. wt. of Ba=137 and S=32).

18.52 An organic compound with the molecular formula $C_xH_{15}O_3P$ has 18.6% of phosphorus. Calculate the value, of 'x' (at. wt. of P=31).

18.53 An organic monocarboxylic acid with no other element than C, O,H, or any other functional group than the COOH group has carbon 68.85% and hydrogen 4.91%. Calculate its molecular mass and give its molecular formula.

18.54 1.367 g of organic compound on combustion in a stream of air yielded 3.002 g CO_2, 1.640 g. H_2O. If the original compound contains only C, H and O, what is its emperical formula ?

18.55 A sample of coal weighs 2.50 g. After drying, the sample weighs 2.415 g. On heating the sample in a partially covered crucible till all volatile matter is removed, the sample weighs 1.528 g. It is then heated in a stream of air till all carbon disappears. The ash weighs 0.245 g. What is the % of moisture, volatiles C and ash in the sample ?

18.56 If w g of an organic compound on vaporisation displaces V litre of air at a pressure of PK · Pa at temperature T K, derive an equation for calculating the molecular mass of the substance.

18.57 0.25 gm of an organic compound gave 38 cm^3 of nitrogen measured at 300^K and 96 kPa pressure. Calculate the % of N in the sample.

18.58 In a Kjeldahl's experiment 0.24 gm of an organic compound was used. The NH_3 evolved was absorbed in 50 cm^3 of $N_4H_2SO_4$. 77cm^3 of $\frac{N}{10}$ NaoH was required for complete neutralisation of the acid. Calculate the % of N in the compound. (given S=32)

18.59 Calculate the % of Br in an organic compound, 0.301 gm of which gives 0.282 gm of AgBr (Gives at. wt. of Br= 80 Ag = 108).

18.60 Calculate the % of S in an organic compound, 0.2175g of which in the Carius method gives 0.5825 gm of $BaSo_4$. (Given, S = 32, Ba = 137)

18.61 An organic compound (A) contained 90% carbon and 10% hydrogen. Treatment with HCl gave a product (B) containing 62.83% chlorine. Hydration of (A) in presence of mercuric ion gave propanone.Identify the compound' A, B.

18.62 A liquid organic compound (A) having 92.30% carbon and 7.7% hydrogen decolourised $KMnO_4$ and on ozonolysis gave formaldehyde and another compound (B). The vapour density of (A) was found to be 52. On treatment with a suitable catalyst, (A) gave a high molecular weight solid product (C) having the same emperical formula as that of compound (A). Compound (C) could be used in making toys and household goods. Identify A, B and C and explain the reactions.

UNIT 19

MOLECULES OF LIFE

I OBJECTIVE TYPE ITEMS

(A) Multiple choice type (write the correct answer).

19.1 The most abundant material present in any living cell is :

a) nucleic acid
b) water
c) lipids
d) proteins

19.2 The major component of any cell membrane is :

a) lipids
b) polysaccharides
c) proteins
d) water

19.3 Identify the incorrect statement regarding cells :

a) All living creatures are made of cells.
b) Cells are the smallest units of life.
c) We can see cells with our naked eyes.
d) They can grow and divide.

19.4 Identify the incorrect statement regarding monosaccharides :

a) There are about twenty naturally occuring monosaccharides.

b) All monosaccharides are polyhydroxy compounds containing a number of alcoholic groups.

c) They also contain either an aldehyde or a keto functional group.

d) Two important monosaccharides are starch and cellulose.

19.5 Which of the following is a disaccharide ?

a) starch
b) ribose
c) fructose
d) maltose

19.6 Which of the following material supplies energy most easily in a living system ?

a) maltose
b) lactose
c) glucose
d) sucrose

19.7 Invert sugar consists of equimolar mixtures of :

a) glucose + fructose
b) glucose + maltose
c) glucose + starch
d) glucose + water

19.8 The function of haemolglobin is to :

a) catalyse biochemical reactions
b) store oxygen in muscles until it is needed for energy reproduction
c) transport oxygen from lungs to various tissues through blood screen
d) help in muscular movement.

19.9 Which of the following monosaccharide forms the important chemical constituent of nucleic acid:

a) glucose
b) fructose
c) mannose
d) ribose

19.10 Milk sugar is :

a) glucose
b) sucrose
c) fructose
d) lactose

19.11 The primary structure of protein was first determined by

a) H.G Khurana
b) F. Sanger
c) J. Watson and F. Crick
d) C. Chandrasekhar

19.12 Identify the incorrect statement regarding enzyme:

a) Enzymes catalyse chemical reaction in living systems.

b) Enzymes themselves are carbohydrates

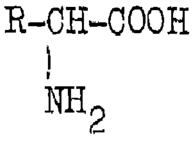
c) Enzymes are biological catalysts.

d) The remarkable properties of the enzyme is their specificity and efficiency.

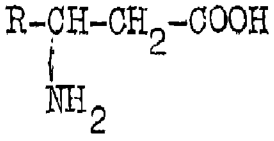
19.13 Viruses are :

a) larger than bacteria
b) lipids coated around a nucleic acid
c) non-living organisms
d) incapable of multiplying themselves as cells do.

19.14 Which of the following structural units is essentially present in alpha-amino acids ?

a) 
$R-\underset{NH_2}{\underset{|}{CH}}-COOH$

b) $RNH-CH-CH_2-COOH$

c) 
$R-\underset{NH_2}{\underset{|}{CH}}-CH_2-COOH$

d) $NH_2-(CH_2)_3-COOH$

19.15 Proteins are characterised by the presence of :

a) ester linkages
b) peptide linkages
c) ether linkages
d) carbide linkages

19.16 Denaturation of protein is due to :

a) change in primary structure
b) rearrangement of secondary and tertiary structure
c) breaking up of peptide bonds
d) interaction with other protein molecules

19.17 In the amino acids glycine $(\underset{COOH}{RCH}-NH_2)$ the side chain R stands for :

a) hydrogen
b) methyl group
c) aryl group
d) hydroxylic group

19.18 Which of the following protein has a corkscrew structure ?

a) silk
b) hair
c) haemoglobin
d) myoglobin.

19.19 Enzymes are essentially :

a) carbohydrates
b) lipids
c) proteins
d) water bonded acids

19.20 Nucleic acids are polymers of :

a) nucleotides
b) peptides
c) lipids
d) nucleoside

19.21 The term DNA stands for :

a) double nucleic acid
b) de-nucleic acid
c) de-oxy nucleic acid
d) de-oxy ribonucleic acid

19.22 The correct sequence of components in nucleic acids is :

a) base-sugar-phosphate
b) base-phosphate-sugar
c) phosphate-base-sugar
d) sugar-sugar-base

19.23 In cell division, original DNA results into the formation of :

a) two identical stands of DNA
b) two identical stands of RNA
c) two RNA
d) two RNA and one DNA

19.24 The segment of DNA which acts as instructional manual for synthesis of protein is :

a) nucleoside
b) nucleotide
c) ribose
d) gene

19.25 Influenza disease is caused by :

a) dietary deficiency
b) insect bite
c) virus
d) bacteria

19.26 Waxes are esters of :

a) lower organic acids and alcohols
b) lower chain fatty acids and alcohol
c) lower fatty acids and long chain alcohol
d) long chain fatty acids and long chain alcohol

19.27 Tri-esters of fatty acids with glycerol are major components of:

a) animal and vegetable carbohydrates
b) animal and vegetable fats
c) animal and vegetable proteins
d) soaps

19.28 Oils and fats being hydrolysed by alkali results into the formation of :

a) lipids
b) proteins
c) triglycerides
d) soaps

B Completion type Items

Complete the following :

19.29 Most biochemical reactions in cells occur in aqueous solutions at pH around __(i)__ at a physiological temperature of __(ii)__ and a __(iii)__ pressure.

19.30 Honey is a rich natural source of ________.

19.31 Glucose molecule is a hexose and ________.

19.32 Fructose molecule is a hexose and a ________.

19.33 The order of sequence in which various amino acids are linked in protein is called the ________.

19.34 In a living system, proteins in food are hydrolysed quite easily to individual amino acids because of the presence of ________ in cell.

19.35 The maximum number of amino acids required to form a peptide bond is ________.

19.36 Defective haemoglobin in the body causes the disease called ________.

19.37 The enzymes that catalyse the reversible reaction of the breakdown of carbonic acid to water and carbon dioxide is called ________.

19.38 The elements which together constitute more than 99% of weight of a living cell are ________.

19.39 The deficiency of enzymes __(i)__ leads to a disease known as __(ii)__ in some mentally retarded children.

C True and false type items:

19.40 Carbohydrates like water contain hydrogen and oxygen in the ratio of 2:1.

19.41 Ribose is an example of monosaccharide.

19.42 Honey is a rich natural source of invert sugar.

19.43 Cotton is made up of 100% cellulose.

19.44 There may be more than one amino group in α-amino acid.

19.45 Proteins are not polyamides.

19.46 Haemoglobine is a hormone.

19.47 The properties of starch and cellulose are different because starch contains glucose and cellulose contains fructose as repeat units.

19.48 In glycine, amino group and acid group are attached to the same carbon atom.

19.49 Wool is an example of fibrous proteins.

19.50 Myoglobin is an example of globular protein.

19.51 Denaturation results from rearrangement of secondary and tertiary structure of proteins.

19.52 Peptide bond involves the alpha amino and alpha carboxylic group as well as the groups present in the side chain.

19.53 Enzymes are not specific in their reactions.

19.54 Carbonic anhydrase is present in the white cells of blood.

19.55 Adenine is a pyrimidine base.

19.56 RNA is directly involved in the synthesis of proteins.

19.57 Virus first invades the host cells and then multiply.

19.58 Lipids are water soluble compounds.

(D) Matching type items

Match the items in list A with relevant answers given in list B by indicating the serial number of items of list A against those of list B.

19.59

	LIST A		LIST B
	carbohydrates		consists of
i)	maltose	a)	one molecule of glucose and one molecule of galactose
ii)	starch	b)	two molecules of glucose
iii)	lactose	c)	three molecules of glucose
iv)	cellulose	d)	four molecules of glucose
		e)	several molecules of glucose - a branched polymer
		f)	several molecules of glucose - a linear polymer

19.60

	LIST A		LIST B
	name		property
i)	insulin	a)	catalyses bio-chemical reactions
ii)	carbonic anhydrase	b)	transports oxygen in blood
iii)	wax	c)	stores oxygen in muscles
iv)	haemoglobin	d)	helps in metabolism of carbohydrates
		e)	catalyses break-down of carbonic acid
		f)	protects surface from water loss and attack by microorganisms

19.61 **LIST A**

carbohydrates

- i) glucose
- ii) monosaccharides
- iii) invert sugar
- iv) starch
- v) cellulose

LIST B

characteristics

- a) carbohydrates that cannot be broken into smaller units upon hydrolysis
- b) enzyme necessary for breaking cellulose into glucose
- c) branched polymers consisting entirely of -glucose units
- d) equimolar mixture of glucose and fructose
- e) a hexose
- f) linear polymers consisting of -glucose

II SHORT ANSWER ITEMS

19.62 What do you know about the composition of living cells ?

19.63 What are the properties of the main chemical constituents of the cell membrane ?

19.64 Give at least two specific functions of the cell membrane.

19.65 What are the main groups of the carbohydrates ?

19.66 Why is it that cow and deer eat grass and digest, whereas humans cannot ?

19.67 Which is the sweetest of all the monosaccharides ?

19.68 What is invert sugar ?

19.69 Give factors responsible for secondary and tertiary structure of protein molecules.

19.70 The secondary and tertiary structure of myoglobin and haemoglobin are different from keratin and collagen. Account for this difference.

19.71 What is a peptide bond ?

19.72 Write the structure of alanine molecule.

19.73 Write two characteristics of enzymes.

19.74 Write two structural differences between DNA and RNA.

19.75 Write two important functions of DNA.

19.76 Name the two pyrimidine bases in RNA.

19.77 Hair and silk both contain protein. Why then can hair be stretched, whereas silk cannot be ?

19.78 Name three human diseases caused by virus.

19.79 Give one example each of DNA and RNA virus.

19.80 Though amide links are very stable, proteins are hydrolysed quite easily in the living system. How does this happen ?

III LONG ANSWER TYPE ITEMS

19.81 In a cell, next to water, all but a tiny fraction is carbon compounds. What do you know about these carbon compounds ?

19.82 Discuss the properties of the three main classifications of the carbohydrates.

19.83 Discuss the structure of proteins.

19.84 What are nucleic acids ? What do you know about the structure of DNA and RNA ? What is the importance of nucleic acids in a living cell ?

19.85 What are the two most important functions of DNA and RNA ? Discuss.

KEY

UNIT I : ATOMS MOLECULES & CHEMICAL ARITHEMATIC

ITEM		KEY	ABILITIES
1.1		c	u
1.2		c	u
1.3		d	u
1.4		a	k
1.5		b	k
1.6		b	u
1.7		b	u
1.8		a	u
1.9		d	u
1.10		c	u
1.11		c	u
1.12		b	u
1.13		b	u
1.14	(a)	10^{-12}	k
	(b)	pressure	k
	(c)	fractical distillation	k
	(d)	multiple proportion	k
	(e)	mass spectrometer	k
1.15	(a)	A_2B	u
	(b)	molecules	k
	(c)	286	k
	(d)	heterogeneous	k
	(e)	chromatography	k

1.16	(a)		3	k
	(b)		zero, integer	k
	(c)		7	k
	(d)	i)	candela, cd	k
		ii)	cd	
	(e)		amu.	k
1.17	(a)		F	k
	(b)		F	k
	(c)		T	k
	(d)		T	k
	(e)		F	k
1.18	(a)		T	k
	(b)		F	k
	(c)		T	k
	(d)		T	u
	(e)		F	u
1.19	(a)		T	k
	(b)		T	k
	(c)		F	k
	(d)		F	k
	(e)		T	k
1.20	(a)		(iii)	u
	(b)		(v)	u
	(c)		(iv)	u
	(d)		(vi)	u
	(e)		(i)	u

1.21	(a)	(vi)	k
	(b)	(iv)	k
	(c)	(i)	k
	(d)	(ii)	k
	(e)	(iii)	k
1.22	(a)	(v)	k
	(b)	(iv)	k
	(c)	(i)	k
	(d)	(iii)	k
1.23			an
1.24			an
1.25			ap
1.26			u
1.27			an
1.28			ap
1.29			ap
1.30			ap
1.31			k
1.32			ap
1.33			ap
1.34		1.23 M	
1.35		3.346×10^{20} molecules	
1.36		4.82×10^{4} C	
1.37		C_3H_8O	
1.38		1.807×10^{23} molecules	
1.39	(a)	0.25 mole	
	(b)	1 mole	
1.40		9.2×10^{-23} gm	

1.41		0.025 mole
1.42		0.75 mole
1.43		0.1 mole
1.44	(a)	0.5 gm
	(b)	3.01×10^{21} molecule
1.45		sugar Rs. 5.93 per kg.
		salt Rs. 1.19 per kg.
1.46		Fe : 27.93 %
		S : 24.02 %
		O : 48.05 %
1.47		2.6 M
1.48		NH_2
1.49		200 gm
1.50		5.61×10^{23} atoms
1.51		b

KEY

UNIT : 2

Elements their Occurence and Extraction

Items	Key	Abilities
2.1	c	k
2.2	a	k
2.3	a	k
2.4	a	k
2.5	b	k
2.6	c	k
2.7	c	k
2.8	d	k
2.9	a	u
2.10	b	k
2.11	a	k
2.12	Ore	k
2.13	iodine	k
2.14	froth floatation	k
2.15	electrolytic	k
2.16 i)	gangue,	k
ii)	silica	k
2.17	concentrate	k
2.18	Fe	k
2.19	complexation	k

2.20	i)	T	k
	ii)	T	k
	iii)	F	k
	iv)	F	k
	v)	F	k
2.21	i)	F	k
	ii)	F	k
	iii)	T	k
	iv)	T	k
	v)	F	k
2.22	a)	iv	k
	b)	iii	k
	c)	ii	k
	d)	i	k
2.23	a)	v	k
	b)	vii	k
	c)	iv	k
	d)	ii	k
	e)	vi	k
	f)	i	k
2.24			k
2.25			u
2.26			k

2.27	u
2.28	k
2.29	k
2.30	u
2.31	k
2.32	an
2.33	k
2.34	k
2.35	k
2.37	u + k
2.38	en
2.39	an
2.40	an

KEY

UNIT 3 : STATES OF MATTER

ITEM		KEY	ABILITIES
3.1		d)	an
3.2		c)	k
3.3		c)	k
3.4		a)	u
3.5		b)	u
3.6		c)	u
3.7		c)	u
3.8		d)	u
3.9		c)	u
3.10		b)	k
3.11		d)	u
3.12		a)	u
3.13		a)	u
3.14		c)	u
3.15		b)	u
3.16		b)	ap
3.17		c)	ap
3.18		d)	u
3.19		c)	u
3.20		b)	u
3.21		a)	u
3.22	i)	low	k
	ii)	insulator	k
	iii)	covalent	k
	iv)	high	k
	v)	ionic	k
	vi)	poor conductor	k

3.23	i)	$>$	k
	ii)	$<$	k
3.24	i)	all	k
	ii)	particular	k
3.25	a)	lower	k
	b)	descreases	k
	c)	increase	k
	d)	the International systems of units (Le system international d' units).	k
3.26	a)	F	u
	b)	T	k
	c)	F	k
	d)	F	u
	e)	F	K
	f)	T	k
3.27	a)	iii)	k
	b)	i)	k
	c)	ii)	k
	d)	iv)	k
3.28	a)	ii)	k
	b)	v)	k
	c)	vi)	k
	d)	i)	k
	e)	iii)	k
3.29			u
3.30			u

3.31	k
3.32	u
3.33	u
3.34	k
3.35	u
3.36	u
3.37	u
3.38	k
3.39	u
3.40	u
3.41	u
3.42	u
3.43	u
3.44	u
3.45	k
3.46	k
3.47	u
3.48	an
3.49	ev
3.50	ev
3.51	i) Nitrogen
	ii) 121.56 kPa
3.52	1.716 kg/m^3
3.53	60 gm/mole
3.54	0.24 kg/m^3
3.55	2.69×10^{19} molecules
3.56	3.996 gm
3.57	first offer
3.58	more molecules of H_2O
3.59	484 ms^{-1}

3.59	484 ms^{-1}
3.60	61.18 kPa
3.61	Partial pressure of nitrogen, oxygen and argon are 7.91 kPa, 21.17 kPa and 0.9 kPa respectively.
3.62	17.7 kJ/mole of H.bond
3.63	3.3×10^{-3} milli mole.
3.64	2878 pm
3.65	143 pm
3.66	408.7 pm
3.67	11.18^{0}

KEY

UNIT - 4 : ATOMIC STRUCTURE

SL.NO. OF QUESTIONS		KEY	ABILITIES
4.1		d	k
4.2		c	u
4.3		b	k
4.4		a	u
4.5		b	k
4.6		b	k
4.7		c	u
4.8		b	u
4.9		b	k
4.10		b	k
4.11		b	k
4.12		d	k
4.13		a	k
4.14		d	u
4.15		a	u
4.16		c	k
4.17		b	k
4.18		a	k
4.19		a	u
4.20		d	u
4.21		radioactivity	
4.22		Rutherford	k
4.23	i)	reflection,	k
	ii)	refraction,	k
	iii)	interference,	k
	iv)	diffraction.	k

4.24	30
4.25	0, ±1, ±2, ±3
4.26	4s
4.27	3
4.28	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$
4.29	Hund's Rule
4.30	binding energy
4.31	i) X, ii) X, iii) (Y-X)
4.32	i) 4s, ii) 3d, iii) 5s, iv) 4d, v) 5p
4.33	$6.63 \times 10^{-34}\ Js^{-1}$
4.34	Photons
4.35	i) particles, ii) particles iii) rays
4.36	i) greater ii) lower
4.37	i) 2, ii) 6, iii) 32
4.38	zero
4.39	[illegible] frequency/wavelengths.
4.40	spin
4.41	T
4.42	T
4.43	F
4.44	T
4.45	T
4.46	F
4.47	T
4.48	F
4.49	T
4.50	F
4.51	T
4.52	F
4.53	F
4.54	T

4.55		F	
4.56		T	
4.57		F	
4.58		T	
4.59		T	
4.60	a)	iv)	
	b)	i)	
	c)	iii)	
	d)	ii)	
4.61			u
4.62			an
4.63			u
4.64			k
4.65			u
4.66			k
4.67			u
4.68			ev
4.69			ev
4.70			k
4.71			k
4.72			ev
4.73			ev
4.74			k
4.75			u
4.76			k
4.77			ev
4.78			k
4.79			ev
4.80			714 kilo Hertz
4.81			63.38 amu
4.82			91.17 nm
4.83			6.7×10^{14} Hz.
4.84			486 nm
4.85			1.65×10^{-19} J.

KEY

UNIT - 5

Chemical Families - Periodic Properties

Item		Key	Abilities
5.1		a	k
5.2		d	k
5.3		b	k
5.4		a	k
5.5		a	k
5.6		b	k
5.7		b	k
5.8		d	k
5.9		a	k
5.10		d	k
5.11		d	u
5.12		c	k
5.13		b	u
5.14		b	u
5.15		d	u
5.16		b	u
5.17		atomic number	k
5.18		atomic number	k
5.19		ionisation energy	k
5.20		electron affinity	k
5.21		Astatine	k
5.22		Francium	k
5.23		F	k
5.24	i)	decreases	k
	ii)	increases	k

5.25		electrons	k
5.26		f	k
5.27		electronic configuration	k
5.28		nuclear charge	k
5.29		single	k
5.30		CF_4	k
5.31		increase	k
5.32		group number	k
5.33		atomic number	k
5.34		4	k
5.35	a)	F	k
	b)	T	u
	c)	T	k
	d)	F	k
	e)	T	k
5.36	a)	T	k
	b)	T	k
	c)	F	k
	d)	F	k
	e)	F	k
5.37	a)	F	k
	b)	F	k
	c)	T	k
	d)	F	k
	e)	T	k
5.38	a)	iii)	k
	b)	i)	k
	c)	ii)	k
	d)	v)	k

5.39	a)	ii)	k
	b)	iii)	k
	c)	i)	k
5.40	a)	iii)	u
	b)	iv)	u
	c)	ii)	u
	d)	i)	u
	e)	vi)	u
5.41	a)	iii)	k
	b)	i)	k
	c)	vi)	k
	d)	iv)	k
	e)	ii)	k
5.42	a)	iii)	k
	b)	v)	k
	c)	vi)	k
	d)	i)	k
5.43	a)	ii)	u
	b)	iii)	u
	c)	iv)	u
	d)	v)	u
5.44	a)	v)	u
	b)	ii)	u
	c)	iii)	u
	d)	i)	u

5.45	a)	iii)	u
	b)	ii)	u
	c)	iv)	u
	d)	i)	u
5.46			k
5.47			k
5.48			k
5.49			u
5.50			an
5.51			k
5.52			k
5.53			k
5.54			ap
5.55			an
5.56			an
5.57		2.4×10^3 kg/m^3 for C	
	and		
		1×10^3 kg/m^3 for N	
5.58		112 kJ	
5.59		148 kJ. Energy absorbed.	

KEY :

UNIT-6 : BONDING AND MOLECULAR STRUCTURE

ITEM		KEY	ABILITIES
6.1		b	k
6.2		b	k
6.3		c	k
6.4		a	k
6.5		c	k
6.6		b	k
6.7		b	k
6.8		a	k
6.9		b	u
6.10		b	k
6.11		b	u
6.12		b	u
6.13		c	k
6.14	i)	b	ap
	ii)	b	ap
	iii)	b	ap
	iv)	a	ap
6.15		d	u
6.16		d	k
6.17		a	k
6.18		d	k
6.19		d	k
6.20		c	k
6.21		d	u

6.22	a)		three	k
	b)		bond length	k
	c)	i)	identical	k
		ii)	tetrahedral	k
	d)	i)	s	k
		ii)	p	k
	e)		rotation	k
6.23	a)		side ways	k
	b)	i)	below	k
		ii)	above	k
	c)		hydrogen	k
	d)		electronegative	k
	e)		paramagnetic	k
6.24	a)	i)	empirical formula	k
		ii)	structural formula	k
		iii)	molecular formula	k
	b)		covalent	k
	c)	i)	nonbonding	k
		ii)	loan	k
		iii)	unshared	k
	d)		valence shell electron pair repulsion	k
	e)		bond	k
6.25	a)		polar	k
	b)		electronegativities	k
	c)		Linus Pauling	k
	d)		shared	k
	e)		flourine	k

6.26	a)	F	k
	b)	T	k
	c)	T	k
	d)	T	k
	e)	F	k
6.27	a)	T	k
	b)	T	k
	c)	F	k
	d)	T	k
	e)	T	k
6.28	a)	T	k
	b)	T	k
	c)	T	k
	d)	F	k
	e)	T	k
6.29	a)	iv)	k
	b)	i)	k
	c)	v)	k
	d)	iii)	k
	e)	ii)	k
6.30	a)	iii)	k
	b)	iv)	k
	c)	i)	k
	d)	ii)	k
		)	k
6.31	a)	v)	k
	b)	iv)	k
	c)	i)	k
	d)	ii)	k
	e)	iii)	k

6.32			k
6.33			u
6.34			k
6.35			u
6.36			u,
6.37			k
6.38			u
6.39			k
6.40			ap
6.41			an
6.42			k
6.43			k
6.44			k
6.45			ap
6.46			u
6.47			k
6.48			k
6.49			an
6.50			k
6.51			u
6.52			k
6.53			u
6.54			ap
6.55			k
6.56			an
6.57	a)	4.528×10^{-29} Cm	
	b)	- - $\overset{+\dashrightarrow}{\text{Nacl}}$	
6.58		76.8 %	

KEY

UNIT 7: CARBON & ITS COMPOUNDS

ITEM	KEY	ABILITIES
7.1	a	k
7.2	b	k
7.3	c	k
7.4	c	k
7.5	a	k
7.6	c	k
7.7	b	k
7.8	a	k
7.9	a	k
7.10	d	u
7.11	c	u
7.12	c	u
7.1	b	u
7.14	d	u
7.15	a	u
7.16	b	k
7.17	b	k
7.18	d	k
7.19	Catenation	k
7.20	isomers	k
7.21	sp^2	k
7.22	dry ice	k
7.23	harden	k
7.24	lubricant	k
7.25	carborundum	k

7.26		methanal	k
7.27		functional group	k
7.28	i) ii)	CO_2 CO_3	k k
7.29		temperory.	k
7.30		allotropy	k
7.31		acetylene	k
7.32		reducing agent	k
7.33		carbon black	k
7.34		International Union of Pure & Applied Chemistry	k
7.35		refrigerant	k
7.36	i) ii)	Urea Amonoium cynate	k
7.37	i) ii)	alkaline hydrolysis	k
7.38		trinitrotoluene	k
7.39		Liquefied Petroleum Gas	k
7.40		Carbohydrates ii) fats	k
7.41	i) ii)	catenation isomerism	k
7.42		carbon monoxide	k
7.43		i) steam ii) coke	k
7.44		carbon dioxide ii) pressure	k
7.45		tungsten	k
7.46		unsaturated	k
7.47		i) Coal ii) Petroleum	k
7.48		ethanoic acid	k
7.49		refrigeration	k

7.50	napthalene	k
7.51	T	u
7.52	T	k
7.53	T	k
7.54	F	k
7.55	T	u
7.56	T	k
7.57	T	k
7.58	F	u
7.59	T	u
7.60	F	u
7.61	T	u
7.62	F	u
7.63	F	u
7.64	F	u
7.65	F	k
7.66 i)	c	k
~~iii~~ ii)	d	k
iii)	e	k
iv)	a	k
7.67 i	c	k
ii	a	k
iii	e	k
iv	d	k
7.68 i	a	k
ii	b	k
iii	c	k
iv	e	k

7.69	i	d	k
	ii	a	k
	iii	b	k
	iv	c	k
7.70	i	d	u
	ii	b	u
	iii	e	u
	iv	a	u
7.71	i	d	k
	ii	b	k
	iii	c	k
	iv	a	k
7.72	i	b	u
	ii	a	u
	iii	e	u
	iv	c	u
7.73			an
7.74			u
7.75			k
7.76			k
7.77			k
7.78			u
7.79			
7.80			u
7.81			k
7.82			k
7.83			an
7.84			k
7.85			k
7.86			k
7.87			k
7.88			k
7.89			an
7.90			k

KEY KEY

UNIT : 8 : ENERGETICS

[illegible]

ITEM		KEY	ABILITIES
8.1		d	k
8.2		b	k
8.3		b	u
8.4		c	u
8.5		c	u
8.6		b	u
8.7		b	u
8.8		b	k
8.9		a	u
8.10		c	u
8.11		d	an
8.12		c	k
8.13		a	ev
8.14		c	ev
8.15		b	k
8.16		c	u
8.17		d	u
8.18		a	ap
8.19		internal energy	k
8.20		sun	k
8.21		non-renewable	k
8.22	i)	sulphur	k
	ii)	nitrogen	k

7.69 i

8.23	i)	oxygen	k
	ii)	incomplete	k
	iii)	carbon monoxide	k
8.24		equilibrium	k
8.25		steam	k
8.26		negative	k
8.27		sun	k
8.28	i)	$H^+ + OH^- \longrightarrow H_2O$	k
	ii)	neutralisation	k
8.29	i)	evolved	k
	ii)	negative	k
8.30	i)	enthalpy	k
	ii)	more	k
	iii)	oxygen	k
8.31		endothermic	k
8.32	i)	gram equrivlent	k
	ii)	gram equivalent	k
8.33		geothermal	k
8.34		open	k
8.35	i)	isolated	k
	ii)	surrounding	k
8.36	i)	by	k
	ii)	surounding	k
8.37	i)	Tarapur	k
	ii)	Kalpakkam	k
8.38	i)	endothermic	k
	ii)	positive	k
8.39	i)	heat	k
	ii)	work	k
8.40	i)	electrical	k
	ii)	mechanical	k
	iii)	light	k

8.41		T	k
8.42		F	k
8.43		F	k
8.44		T	k
8.45		T	k
8.46		T	k
8.47		F	k
8.48		F	k
8.49		F	k
8.50		F	k
8.51		F	k
8.52		T	k
8.53		T	u
8.54		T	k
8.55		T	u
8.56		F	u
8.57		F	k
8.58		F	u
8.59		T	k
8.60		F	k
8.61	i)	e	k
	ii)	g	k
	iii)	f	k
	iv)	a	k
	v)	c	k
	vi)	d	k
	vii)	b	k
8.62	i)	d	k
	ii)	e	k
	iii)	b	k
	iv)	c	k
	v)	a	k
	vi)	f	k

7.69 +

8.63	k
8.64	u
8.65	u
8.66	u
8.67	k
8.68	k
8.69	u
8.70	k
8.71	k + u
8.72	k
8.73	k
8.74	u
8.75	u
8.76	an
8.77	u
8.78	u
8.79	u
8.80	k
8.81	k
8.82	k
8.83	ap
8.84	an
8.85	an
8.86	ap
8.87	an
8.88	an
8.89	an
8.90	an
8.91	an
8.92	an
8.93	u
8.94	u

8.95			An
8.96			An
8.97			Am
8.98		41.5 kJ	
8.99		-273 kJ.	
8.100		-34 kJ.	
8.101		-478.8 kJ	
8.102	a)	$\Delta G = 0$	
	b)	$\Delta S = 21.9$ JK^{-1} mol^{-1}	
8.103	a)	$\Delta G = 0$	
	b)	$\Delta S = 108.9$ JK^{-1} mol^{-1}	
8.104		44.02 X 10^{3} kJ.	

KEY

UNIT - 9

CHEMICAL EQUILIBRIUM

ITEM		KEY	ABILITIES
9.1		d)	u
9.2		d)	u
9.3		c)	u
9.4		d)	k
9.5		b)	u
9.6		a)	k
9.7		a)	u
9.8		c)	u
9.9		d)	u
9.10		c)	k
9.11		a)	u
9.12		d)	u
9.13		c)	u
9.14		d)	u
9.15		lower	u
9.16		lower	k
9.17		neutral	u
9.18		higher	k
9.19		equilibrium	k
9.20		spontaneous	k
9.21		increases	u
9.22	i)	basic	k
	ii)	acidic	k
9.23		equilibrium	k

9.24	a)	Cl	u
	b)	CO_3^{2-}	u
	c)	NH_3	u
	d)	CH_3COOH	u
	e)	HCO_3^-	u
	f)	HCl	u
9.25	i)	F	k
	ii)	F	k
9.26		F	K
9.27		T	k
9.28		F	k
9.29		T	k
9.30		T	u
9.31		T	u
9.32		T	k
6.33		F	u
9.34		F	k
9.35		F	k
9.36		T	k
9.37		T	k
9.38		F	k
9.39	a)	F	k
	b)	T	u
	c)	T	u
	d)	F	u
9.40	a)	T	k
	b)	T	k
	c)	F	k
	d)	F	k

9.41		T	k
9.42		F	k
9.43		T	u
9.44	i)	a	k
	ii)	d	k
	iii)	c	k
	iv)	e	k
	v)	b	k
9.45	i)	b	k
	ii)	a	k
	iii)	c	k
	iv)	f	k
	v)	d	k
9.46	i)	c	k
	ii)	d	k
	iii)	a	k
	iv)	b	k
9.47			an
9.48			an
9.49			an
9.50			ap
9.51			u
9.52			u
9.53			ap
9.54			k
9.55			ap
9.56			k
9.57			k
9.58			k
9.59			k
9.60			k

an

9.61

9.62

9.63 1.6

9.64 H_2 = 2.24×10^{-2} mol L^{-1}

I_2 = 2.24×10^{-2} mol L^{-1}

HI = 0.155 mol L^{-1}

9.65 0.667

9.66 proved

9.67 reaction proceeds to the right

9.68 pOH = 1.80

pH = 12.20

9.69 6.9957

9.70 a) H_3O^+ = Cl^- = .03 mol L^{-1}

OH^- = 0.33×10^{-12} mol L^{-1}

b) H_3O^+ = Cl^- = 0.03 mol L^{-1}

OH^- = 17×10^{-12} mol L^{-1}

9.71 a) Concentration of free

OH^- = 3.6×10^{-5} mol L^{-1}

b) Concentration of free

OH^- = 2.7×10^{-3} mol L^{-1}

9.72 H^+ = 1.3×10^{-3} M

9.73 $pOH = 7.301$

9.74 $pH = 6.13$

9.75 $K_{sp} = 1.6 \times 10^{-8}$

9.76 Solubility is 4.0×10^{-5} mol L^{-1}

9.77 $NH_4^+ = 2.08 \times 10^{-3}$ M

9.78 a) 2.6×10^{-4} M

b) 8.9×10^{-8} M

9.79 There will be a precipitation of AgI.

KEY : UNIT 10

REDOX REACTIONS

ITEM	KEY	ABILITIES
10.1	a)	u
10.2	c)	k
10.3	b)	u
10.4	a)	u
10.5	c)	k
10.6	b)	k
10.7	b)	k
10.8	c)	k
10.9	c)	k
10.10	d)	k
10.11 a)	redox reaction	k
b)	standard hydrogen	k
c) i)	galvanie	k
ii)	electrochemical	k
d)	1 Mol $L^{-1} H_3O^+$	k
e)	oxidation number	k
10.12 a) i)	increase	u
ii)	decrease	u
b)	spontaneous	k
c) i)	oxidised	k
ii)	reduced	k
d) i)	-2	k
ii)	-1	
iii)	+2	
e) i)	cathode	
ii)	anode	
10.13 a) i)	Stock	k
ii)	non metal	k

b) i)	electrons	k
ii)	positive	k
c)	electrolysis	k
d) i)	anode	k
ii)	cathode	k
e)	Electromotive Force(EMF)	
10.14a) i)	Chemical	k
ii)	electrical	k
b) i)	oxidised	k
ii)	reduced	k
c) i)	Fe	k
ii)	lost	k
d) i)	catalyst	k
ii)	H_3O^+	k
e) i)	planised platinum	k
ii)	1 Mol^{L+} $^{-1}$	
iii)	hydrogen	k
iv)	one	k
v)	platinised platinum	k
10.15 a)	F	k
b)	T	k
c)	F	k
d)	F	k
e)	F	u
10.16 a)	T	k
b)	T	u
c)	F	u
d)	T	k
e)	T	k

10.17	i)	e	k
	ii)	c	k
	iii)	a	k
	iv)	b	k
	v)	e	k
	vi)	f	k
10,18			u
10.19			ap
10.20			u
10.21			u
10.22			u
10.23			u
10.24			u
10.25			ap
10.26			u
10.27			u
10.28			k
10.29			u
10.30			k
10.31			u
10.32			u
10.33			ap
10.34			ap
10.35			u
10.36			an
10.37			ap
10.38			u
10.39			ap
10.40			ap
10.41			u
10.42			k

10.43			k
10.44			k
10.45			u
10.46			an
10.47			k
10.48			k
10.49		0.34V	
10.50		non-spontaneous	
10.51		4.8×10^3	
10.52		0.223 V	
10.53		0.34 M	
10.54		1.014 V	
10.55		-419660 J	
10.56		0.2804 V	
10.57	a)	2.00 V	
1	b)	0.78 V	
	c)	4.53 V	
	d)	3.31 V	
10.58	i)	1.05V	
	ii)	1.0205 V	
	iii)	0.9615 V	

KEY

UNIT 11: RATES OF CHEMICAL REACTIONS

ITEM		KEY	ABILITIES
11.1		d	u
11.2		c	u
11.3		b	an
11.4		d	an
11.5		d	u
11.6		c	k
11.7		b	u
11.8		b	k
11.9		b	k
11.10		b	k
11.11	a)	light	k
	b)	mol L^{-1} s^{-1}	k
	c)	$k = C_A{}^1 \ C_B{}^2$	k
	d)	free radicals	k
	e)	10^{-12}	k
11.12	a)	lasers	k
	b)	changes	k
	c)	concentration	k
	d)	increases	k
	e)	energy barrier	k
11.13	a)	faster	k
	b)	activation energy	k
	c)	activation complex	k
	d)	enzymes	k
	e)	elementary reactions	k

11.14	a)	F	k
	b)	F	k
	c)	T	k
	d)	F	k
	e)	T	k
11.15	a)	F	k
	b)	F	k
	c)	T	k
	d)	T	k
	e)	T	k
11.16	a)	T	k
	b)	T	k
	c)	T	k
	d)	F	k
	e)	F	k
11.17	a)	F	k
	b)	T	k
	c)	T	k
	d)	T	k
	e)	F	k
11.18	a)	T	k
	b)	F	k
	c)	F	k
	d)	F	k
	e	T	k
11.19	i)	f	k
	ii)	e	k
	iii)	a	k
	iv)	b	k
	v)	d	k

11.20		an
11.21		k
11.22		k
11.23		u
11.24		an
11.25		ap
11.26		k
11.27		an
11.28		an
11.29		u
11.30		u
11.31		k
11.32		k
11.33		k
11.34		u
11.35		k
11.36	a)	$\text{mol L}^{-1}\ \text{s}^{-1}$
	b)	s^{-1}
	c)	$\text{mol}^{-1}\ \text{L s}^{-1}$
	d)	$\text{mol}^{-2}\ \text{L}^{+2}\ \text{s}^{-1}$
	e)	$\text{mol}^{\frac{1}{2}}\ \text{L}^{-\frac{1}{2}}\ \text{s}^{-1}$
11.37	a)	$2.0 \times 10^{-4}\ \text{mol L}^{-1}\ \text{s}^{-1}$
	b)	$1 \times 10^{-5}\ \text{mol L}^{-1}\ \text{s}^{-1}$
	c)	$3 \times 10^{-5}\ \text{mol L}^{-1}\ \text{s}^{-1}$
	d)	$2.5 \times 10^{-5}\ \text{mol L}^{-1}\ \text{s}^{-1}$
11.38		$3.48 \times 10^{-1}\ \text{mol L}^{-1}\ \text{s}^{-1}$

11.39 a) 5.3×10^{-4} mol L^{-1} s^{-1}

b) 5×10^{-4} mol L^{-1} s^{-1}

c) 5.5×10^{-4} mol L^{-1} s^{-1}

d) 4.5×10^{-4} mol L^{-1} s^{-1}

e) 5×10^{-4} mol L^{-1} s^{-1}

KEY UN[illegible]

UNIT 12: CHEMISTRY OF NON METALS - I

ITEM	KEY	ABILITIES
12.1	d	k
12.2	d	k
12.3	c	k
12.4	c	k
12.5	c	ap
12.6	d	u
12.7	c	ap
12.8	a	k
12.9	d	u
12.10	d	u
12.11	b	u
12.12	b	k
12.13	b	k
12.14	b	k
12.15	b	k
12.16	b	k
12.17	d	k
12.18	c	k
12.19	c	k
12.20	d	k
12.21	c	k
12.22	b	k
12.23	hydrogen	k

12.24		water gas	k
12.25		coolant/moderator	k
12.26		photochemical reaction	k
12.27		reduces	k
12.28		amphoteric	k
12.29		sodium zeolite	k
12.30		oxidising	k
21.31		-1	k
12.32		triple	k
12.33		refrigerant	k
12.34		$NaNO_3$ or KNO_3	k
12.35		trigonal pyramidal	k
12.36	i)	nitric acid	k
	ii)	nitrate	k
12.37		N_2O_4/dinitrogen tetroxide	k k
12.38	a)	4 NO	k
	b)	$2HNO_3$	k
	c)	$Cu(NO_3)_2$	k
	d)	$4Zn(NO_3)_2$	k
	e)	$10NO_2$	k
12.39	a)	F	k
	b)	T	k
	c)	T	k
	d)	F	k
	e)	F	k

12.40 a)	F	k
12. b)	T	k
c)	F	k
d)	F	k
e)	T	k
12.41 a)	T	k
b)	T	k
c)	F	k
d)	T	k
e)	F	k
12.42 i)	a	k
ii)	c	k
iii)	d	k
12.43 i)	d	k
ii)	b	k
iii)	d	k
12.44 i)	c	k
ii)	a	k
iii)	b	k
iv)	e	k
12.45 i)	c	k
ii)	a	k
iii)	f	k
iv)	d	k
v)	b	k

12.46	k
12.47	u
12.48	k
12.49	u
12.50	u
12.51	an
12.52	u
12.53	k
12.54	k
12.55	k
12.56	u
12.57	u
12.58	u
12.59	k
12.60	u
12.61	ap
12.62	k
12.63	k
12.64	an
12.65	an
12.66	an
12.67	an
12.68	u
12.69	u
12.70	k
12.71	k
12.72	k & u

12.72		k & u
12.73	$AgNO_3$	ap
12.74	Oxygen	ap
	Ozone	
	Water	
12.75	aluminium	
	amphotime	

$$Al_2O_3(s)\ 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O$$

$$Al_2O_3(s) + 6NaOH(aq) + 3H_2O \rightarrow 2Na_3[Al(OH)_6](aq)$$

KEY : .)

UNIT : 13: CHEMISTRY OF NON METALS - II

ITEM		KEY	ABILITIES
13.1		c	k
13.2		a	u
13.3		b	k
13.4		d	k
13.5		d	k
13.6		a	k
13.7		c	u
13.8		b	k
13.9		d	k
13.10		b	k
13.11		c	k
13.12		b	k
13.13		d	k
13.14		c	u
13.15		a	k
13.16		b	k
13.17	i)	13	k
	ii)	next	k
	iii)	diagonally accoress	k
13.18		deficient	k
13.19		Si-O-Si	k

13.20		reducing	k
13.21		boric oxide/borax	k
13.22		$(SiO_4)^{4-}$	k
13.23		dehydration	k
13.24		chlorine	k
13.25		carborundum	k
13.26		astatine	k
13.27		oxidising	k
13.28	i)	HBO_2	k
	ii)	B_2O_3	k
	(b)	SiO_4^{4-}	k
	(c)	2 $Ca_3(Po_4)_2$	k
	(d)	$4H_3PC_4$	k
	(e)	11 O_2	k
F)	i)	4 HCL	k
	ii)	Cl_2	k
13.29	a)	T	k
	b)	F	k
	c)	T	k
	d)	F	k
	e)	F	k

13.30	a)	T	k
	b)	F	k
	c)	F	k
	d)	T	k
	e)	F	k
13.31	a)	F	k
	b)	F	k
	c)	T	k
	d)	T	k
	e)	T	k
13.32	a)	F	k
	b)	T	k
	c)	T	k
	d)	F	k
	e)	T	k
13.33	a)	F	k
	b)	F	k
	c)	T	k
	d)	T	k
	e)	F	k
13.34	i)	d	k
	ii)	e	k
	iii)	b	k
	iv)	a	k

13.35	i)	g	k
	ii)	f	k
	iii)	e	k
	iv)	a	k
	v)	b	k
	vi)	c	k
13.36	i)	c	k
	ii)	e	k
	iii)	b	k
	iv)	a	k
13.37	i)	e	k
	ii)	a	k
	iii)	f	k
	iv)	b	k
	v)	d	k
	vi)	g	k
13.38	i)	c	k
	ii)	a	k
	iii)	b	k
13.39			u
13.40			u
13.41			u
13.42			u
13.43			u
13.44			k
13.45			k

13.46		k
13.47		k
13.48		k
13.49		u
13.50		k
13.51		k
13.52		an
13.53		an
13.54		u
13.55		u
13.56		an
13.57		k
13.58		u
13.59		an
13.60		u
13.61		u
13.62		u
13.63		u
13.64		k & an
13.65		k & an
13.66		an
13.67		an
13.68		u
13.69		k
13.70		an
13.71	A is SO_4^{2-} B is $S_2O_3^{2-}$	
13.72	energy calculation prove the result	k

KEY UNIT 14

UNIT: 14 : CHEMISTRY OF LIGHTER ELEMENTS

ITEM		KEY	ABILITIES
14.1		d	k
14.2		c	k
14.3		a	u
14.4		c	u
14.5		c	u
14.6		d	k
14.7		d	u
14.8		c	k
14.9		c	k
14.10		c	k
14.11		d	k
14.12		b	k
14.13		density	k
14.14	i)	electrolytic	k
	ii)	ahlorides	k
14.15		neon	u
14.16		higher	u
14.17		kerosene	k
14.18		ionic	u
14.19		alkaline	u
14.20	i)	smaller	u
	ii)	tightly	u

14.21			nagnesium sulphate	k
14.22			gypsum/clacium sulphate dihydrate	k
14.23	a)		KOH	k
	b)		KO_2	k
	c)		Na_2O_2	k
	d)	$Ca(HcO_3)_2$		k
	e)		$(CaOs_4)_2$	k
	f)		$NaAlO_2$	
14.24	a)		F	k
	b)		T	k
	c)		T	k
	d)		T	k
	e)		T	k
14.25	a)		F	k
	b)		T	k
	c)		F	k
	d)		T	k
	e)		F	k
14.26	a)		F	k
	b)		T	k
	c)		T	k
	d)		F	k
	e)		F	k

14.27	i)	d	u
	ii)	c	u
	iii)	a	u
	iv)	e	u
14.28	i)	d	k
	ii)	c	k
	iii)	a	k
	iv)	b	k
14.29	i)	e	k
	ii)	d	k
	iii)	a	k
	iv)	c	k
14.30	i)	f	k
	ii)	a	k
	iii)	b	k
	iv)	e	k
	v)	g	k
14.31	i)	e	k
	ii)	b	k
	iii)	c	k
	iv)	a	k

14.32	i)	b	k
	ii)	c	k
	iii)	e	k
	iv)	f	k
	v)	a	k
14.33	i)	e	u
	ii)	a	u
	iii)	b	u
	iv)	c	u
14.34			u
14.35			k
14.36			u
14.37			k
14.38			u
44.39			k
14.40			u
14.41			u
14.42			k
14.43			k
14.44			k
14.45			k
14.46			k
14.47			k
14.48			u
14.49			k

14.50	k +.an
14.51	k
14.52	k
14.53	k
14.54	u
14.55	u
14.56	u
14.57	k

KEY

UNIT -- 15

UNIT: 15: CHEMISTRY OF HEAVIER METALS

ITEM			KEY	ABILITIES
15.1			d	k
15.2			c	k
15.3			c	k
15.4			d	k
15.5			a	k
15.6			d	k
15.7			b	k
15.8			b	k
15.9			a	k
15.10			b	u
15.11			c	u
15.12			c	k
15.13			c	k
15.14			a	k
15.15			b	k
15.16	a)		carbon	k
	b)		tempering	k
	c)		annealing	k
	d)	i)	+ 2	k
		ii)	+ 3	k
	e)	i)	smelting	k
		ii)	refining	k

15.17	a)		anode mud	k
	b)		South Africa	k
	c)		parting	k
	d)	i)	impure silver	k
		ii)	pure silver	k
	e)		oxide	k
15.18	a)		Nessler's reagent	k
	b)		sodium zincate	k
	c)		tin	k
	d)	i)	PbO_2	k
		ii)	PbO	k
	e)	i)	$Pb\ (OH)_2$	k
		ii)	$Pb\ (CO_3)_2$	k
15.19	a)		T	k
	b)		T	k
	c)		T	k
	d)		F	k
	e)		T	k
15.20	a)		F	k
	b)		F	k
	c)		F	k
	d)		T	k
	e)		F	k

15.21	a)		T	k
	b)		F	k
	c)		T	k
	d)		F	k
	e)		F	k
15.22	a)		2Fe	k
	b)		2FeO	k
	c)		$4\ Ag(CN)_2^-$	k
	d)		$K_2\ Zn(CN)_4$	k
	e)		6 Cu	k
	f)	i)	$Aucl_3$	k
		ii)	Aucl	k
	g)		$Zn(OH)_4^{2-}$	k
15.23	a)		$SnCl_4$	k
	b)		$PbCl_2$	k
	c)	hydrated	SnO_2	k
	d)		$Pb(NO_3)_2$	k
	e)		$2Pb_3O_4$	k
15.24	i)		d	k
	ii)		a	k
	iii)		b	k
	iv)		c	k

15.25	i)	c	k
	ii)	a	k
	iii)	b	k
	iv)	c	k
	v)	d	k
15.26	i)	b	k
	ii)	d	k
	iii)	c	k
	iv)	a	k
	v)	f	k
15.27	i)	a	k
	ii)	d	k
	iii)	c	k
	iv)	b	k
15.28			k
15.29			k
15.30			ap
15.31			k
15.32			k
15.33			k
15.34			u
15.35			an
15.36			u
15.37			an

15.38		u
15.39		k
15.40		k
15.41		k
15.42		k
15.43		k
15.44		k
15.45		k
15.46		k
15.47		k
15.48		k
15.49		u
15.50		k
15.51		k
15.52		uk
15.53		u
15.54		u
15.55		u
15.56		u
15.57		u
15.58	Ag	an
15.59	A, B, C are Cu, Ag, Au, R is Au P is AgCl S is copper amino complex	ap

KEY

UNIT: 16 STRUCTURE AND SHAPE(S) OF HYDROCARBONS

ITEM	KEY	ABILITIES
16.1	a	u
16.2	c	k
16.3	b	k
16.4	c	u
16.5	a	k
16.6	b	u
16.7	c	u
16.8	c	u
16.9	a	u
16.10	c	u
16.11	b	u
16.12	c	u
16.13	d	u
16.14	a	u
16.15	a	u
16.16	d	k
16.17	a	u
16.18	a	u
16.19	d	u
16.20	b	u
16.21	c	u
16.22	c	u
16.23	chiral	k
16.24	conformers	k
16.25	disymmetric	k
16.26	superimposed	k
16.27	dextrorotatory	k
16.28	restricted	k
16.29	increases	k
16.30	delocalised	k
16.31	more	k
16.32	more	k
16.33	isolated	k
16.34	geometrical	k
16.35	resolution	k
16.36	racemic	k
16.37	polarimeter	k
16.38	Nicol prism	k
16.39	structural isomers	k
16.40	cyclic	k
16.41	i) sigma (σ) ii) pi (π)	k
16.42	2	k
16.43	ascymetric synthesise	k

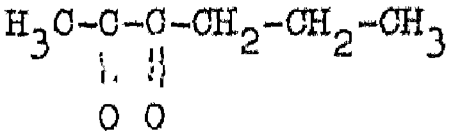
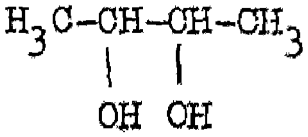
16.44	(4n + 2)		k
16.45	(i) one, (ii) three		k
16.46	two		k
16.47	higher		k
16.48	lower		k
16.49	i) lateral ii) endwise		k
16.50	symmetric		k
16.51	i) 90° ii) cyclopropane		k
16.52	i) canonical forms or resonance forms ii) resonance hybrid		k
16.53	resonance stabilization		k
16.54	i) Van't Hoff ii) Le Bel		
16.55	F		k
16.56	T		k
16.57	F		k
16.58	T		k
16.59	F		k
16.60	F		k
16.61	T		k
16.62	F		k
16.63	T		k
16.64	T		k
16.65	F		k
16.66	T		k
16.67	T		k
16.68	T		k
16.69	i) a	a	k
	ii) c	c	k
	iii) b	b	k
16.70	i) a	a	k
	ii) c	c	k
	iii) b	b	k
	iv) f	f	k
	v) e	e	k
	vi) d	d	k
16.71	i) b	b	u
	ii) d	d	u
	iii) e	e	u
16.72			u
16.73			k
16.74			k
16.75			k

16.76	k
16.77	u
16.78	u
16.79	k
16.80	u
16.81	u
16.82	-
16.83	k
16.84	k
16.85	k
16.86	k
16.87	k
16.88	u
13.89	u
16.90	An

KEY

UNIT : 17 PREPARATION AND PROPERTIES OF HYDROCARBONS

ITEM NO.		KEY	ABILITY
17.1		c	u
17.2		b	k
17.3		c	k
17.4		d	k
17.5		d	u
17.6		a	k
17.7		b	k
17.8		c	k
17.9		b	k
17.10		a	k
17.11		a	k
17.12		b	u
17.13		c	u
17.14		c	k
17.15		d	u
17.16	a)	(iii)	u
	b)	(ii)	u
17.17	a)	H_3C-CH_3	
	b)	H_3C-CH_2MgBr	
	c)	C_4H_{10}	
	d)	C_2H_6	
	e)	CH_4	

17.18	a)	$H_3C-HC=CH_2$	u
	b)	$H_3C-CH_2HC=CH-CH_3$	u
	c)	i) $CH_2=CH\underline{R}.^{Br}$ ii) CH_3CHBr_2	u
	d)	i) $CH_3CH\ CH_3$ ii) $CH_3CH_2\ CH_2OH$	u
	e)	CH_3CH_2COOH	u
17.19	a)	 $H_3C-\underset{O}{\underset{\|}{C}}-\underset{O}{\underset{\|}{C}}-CH_2-CH_2-CH_3$	u
	b)	$CH_3CH=CH_2$	u
	c)	$H_2O = CHOH.$	u
	d)	 $H_3C-\underset{OH}{\underset{\mid}{CH}}-\underset{OH}{\underset{\mid}{CH}}-CH_3$	u
	e)	$CH_3CH_2CH_2Br$	u
17.20	a)	dehydration	k
	b)	weakly	k
	c)	addition	k
	d)		k
	e)	stability	k

17.21	a)	T	k
	b)	F	k
	c)	F	k
	d)	T	u
	e)	T	k
17.22	a)	F	k
	b)	T	k
	c)	T	k
	d)	T	k
	e)	T	k
17.23	a)	T	k
	b)	F	k
	c)	T	k
	d)	T	k
	e)	F	k
17.24	a)	F	k
	b)	T	k
	c)	T	k
	d)	T	k
	e)	T	k
17.25	a)	ii)	k
	b)	iv)	k
	c)	iii)	k
	d)	v)	k
	e)	i)	k

17.26	a)	iv)	k
	b)	i)	k
	c)	iii)	k
17.27	a)	iii)	k
	b)	i)	k
17.28			k
17.29			k
17.30			k
17.31			k
17.32			k
17.33			k
17.34			k
17.35			k
17.36			k
17.37			u
17.38			u
17.39			u
17.40			k
17.41			k
17.42			k
17.43			k
17.44			u
17.45			u
17.46			an
17.47			u
17.48			an
17.49			u
17.50			an

17.51		k
17.53		u
17.54		u
17.55		ap
17.56		ap
17.57		ap
17.58		k
17.59		ap
17.60		k
17.61		k
17.62		k
17.63		ap
17.64		u
17.65		k
17.66		ap
17.67		u
17.68		ap
17.69		k
17.70		u
17.71		k
17.72		k
17.73		k
17.74		an
17.75		u
17.76		k
17.77		k
17.78		k
17.79		k
17.80		k
17.81		k
17.82		k
17.83		k
17.84		k
17.85	10.035 Kg.	
17.86	50	
17.87	8.89m^3	

KEY TO UNIT 18

PREPARATION AND CHARACTERISATION OF ORGANIC COMPOUNDS

ITEM		KEY	ABILITIES
18.1		c	u
18.2		b	u
18.3		b	k
18.4		b	u
18.5		b	k
18.6		b	u
18.7		c	u
18.8		c	k
18.9		a	u
18.10		a	k
18.11		b	u
18.12		c	u
18.13	a)	$PbS + 2CH_3COONa$	
	b)	$Na_4[Fe(CN)_5NOS]$	u
	b)	$Fe(SCN)_3 + 3Na^+$	u
	d)	$AgCl + NaNO_3$	u
18.14	a)	Sulphur	k
	b)	i) Sulphur ii) Nitrogen	k
	c)	ferric thiocynate or $Fe(SCN)_3$	k
	d)	sodium peroxide or Na_2O_2	k
	e)	bromine	k

18.15	a)	(i) $MgNH_4PO_4$,	k
	b)	nitrogen	k
	c)	(i) $(NH_4)_2 SO_4$, (ii) NH_3.	k
	d)	(i) water vapor (H_2O), (ii) CO_2	k
18.16	a)	Victor Meyer's	k
	b)	volumetric	k
	c)	elevation of boiling point, depression of freezing point	k
	d)	emperical formula	k
18.17	a)	molecular mass	k
	b)	(i) nuclear magnetic resonance,	k
		(ii) infra red	k
18.18	a)	air	k
	b)	nitrogen	k
	c)	ammonia	k
	d)	water vapour	k
18.19		(i) steam volatile,	k
		(ii) sparingly soluble	k
18.20		reduced pressure	k
18.21		lower	k
18.22	i)	b)	u
	ii)	a)	u
	iii)	f)	u
	iv)	d)	u

18.23	i)	d)	k
	ii)	b)	k
	iii)	a)	k
18.24			an
18.25			ap
18.26			an
18.27			k
18.28			u
18.29			u
18.30			k
18.31			u
18.32			u
18.33			k
18.34			k
18.35			k
18.36			k
18.37			k
18.38			k
18.39			k
18.40			k
18.41			u
18.42			u
18.43			k
18.44			k
18.45			k
18.46			k
18.47			an
18.48	i)	Wt. of CO_2=0.5060 g	
	ii)	Wt. of H_2O=0.0864 g	
18.49		amount of $CaCO_3$=600 g	
18.50		molecular mass = 157	

18.51 76 g of thiourea

18.52 $x = 6$

18.53 molecular mass = 122

18.5 molecular formula = C_6H_5COOH

18.54 C_3H_8O

18.55 % moisture = 3.4

% volatile matter = 35.5

% carbon = 51.32

% ash = 9.8

18.56

$$\frac{W \times T \times 101.325}{P \times 273 \times V} \times 22.4$$

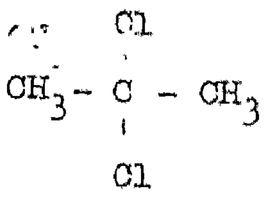
18.57 16.37 %

18.58 28 %

18.59 39.86 %

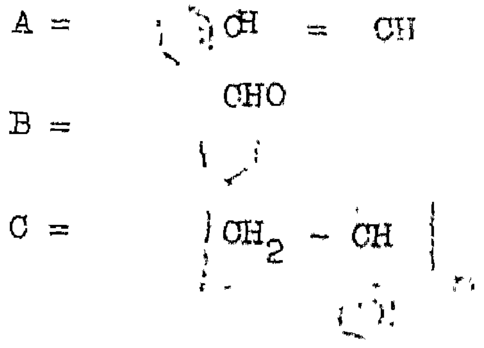
18.60 36.78 %

18.61 A is $CH_3C \equiv CH$



$$CH_3-\underset{Cl}{\overset{Cl}{C}}-CH_3$$

18.62



KEY

UNIT: 19: MOLECULES OF LIFE

ITEM	KEY	ABILITIES
19.1	b	k
19.2	a	k
19.3	c	k
19.4	d	k
19.5	d	k
19.6	c	k
19.7	a	k
19.8	c	k
19.9	d	k
19.10	d	k
19.11	b	k
19.12	b	k
19.13	d	u
19.14	a	k
19.15	b	k
19.16	b	k
19.17	a	k
19.18	b	k
19.19	c	k
19.20	a	k
19.21	d	k
19.22	a	k
19.23	a	k
19.24	d	k
19.25	c	k

19.26	d	k
19.27	b	k
19.28	d	k
19.29	(i) 7, (ii) 310K/37°C (iii) atmospheric	k
19.30	invert sugar	k
19.31	aldose	k
19.32	ketose	k
19.33	primary structure	k
19.34	enzymes	k
19.35	two	k
19.36	sickle cell anaemia	k
19.37	carbonic anhydrase	k
19.38	C,H,N,O,P and S	k
19.39	(i) phenylalanine hydroxylase, (ii) phenyl ketone urea	k
19.40	T	k
19.41	T	k
19.42	T	k
19.43	F	k
19.44	T	k
19.45	F	k
19.46	F	k
19.47	F	k
19.48	T	k
19.49	T	k
19.50	T	k

19.51		T	k
19.52		F	k
19.53		F	k
19.54		F	k
19.55		F	k
19.56		F	k
19.57		T	k
19.58		F	k
19.69	i)	b	k
	ii)	e	k
	iii)	a	k
	iv)	f	k
19.60	i)	d	k
	ii)	c	k
	iii)	f	k
	iv)	b	k
19.61	i)	c	k
	ii)	a	k
	iii)	d	k
	iv)	c	k
	v)	f	k
19.62			k
19.63			k
19.64			k
19.65			k
19.66			k
19.67			k

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SOLUTIONS OF NUMERICAL PROBLEMS

UNIT-I

ATOMS, MOLECULES AND CHEMICAL ARITHMETIC

1.34 10% aqueous solution of H_2SO_4 by mass means :

10 g of H_2SO_4 is present in 100 g of its solution

Molecular mass of H_2SO_4 $= 2 \times 1 + 32 + 4 \times 16$

$= 2 + 32 + 64$

$= 98$ gm mole^{-1}

Number of moles of sulphuric acid $= \dfrac{10\ \cancel{gm}}{98\ \cancel{gm}\ mol^{-1}}$

Volume of the solution $= \dfrac{100\ gm}{1.2\ g/cm^3}$

Molarity of sulphuric acid is no. of moles of sulphuric acid present in 1 litre solution

$$= \frac{10}{98 \times \dfrac{100\ \cancel{gm}}{1000\ \cancel{cm}^3 \times 1.2\ \dfrac{\cancel{gm}}{\cancel{cm}^3}}}$$

$$= \frac{10 \times 1000 \times 1.2}{98 \times 100} = \frac{100 \times 1.2}{98}$$

$$= \frac{120}{98} = 1.23\ M$$

1.35 Mass of a drop of water = .01 g

Molecular mass of water = 18 gm mol^{-1}

Number of molecules = $\dfrac{.01 \text{ gm}}{18 \text{ gm } \cancel{\text{mol}}^{-1}} \times 6.023 \times 10^{23} \cancel{\text{mol}}^{-1}$

= 3.345×10^{20} molecules

1.36 The charge present on 1 proton = 1.6×10^{-19} C

Number of protons present in 1 mole = 6.023×10^{23}

Charge present on 1 mole = $1.6 \times 10^{-19} \times 6.023 \times 10^{23}$ C

Charge present on 0.5 mole = $0.5 \times 1.6 \times 10^{-19} \times 6.023 \times 10^{23}$ C

= 4.82×10^{4} coloumb

1.37 % of carbon in the organic compound = 60

% of hydrogen in the organic compound = 13.3

% of oxygen = 100 - (60+13.3)

= 100 - 73.3

= 26.7

symbol of element	percentage	atomic mass	relative No. of atoms	simple whole number ratio
C	60.0	12	$\frac{60}{12} = 5.0$	$\frac{5.0}{1.67} = 3$
H	13.3	1	$\frac{13.3}{1} = 13.3$	$\frac{13.3}{1.67} = 8$
O	26.7	16	$\frac{26.7}{16} = 1.67$	$\frac{1.67}{1.67} = 1$

Emperical formula of the compound $= C_3H_8O$.

1.38 Mass glucose = 5.4 g.

Molecular mass of glucose ($C_6H_{12}O_6$) $= 6x12+12x1+6x16$

$= 72 + 12 + 96$

$= 180$

Number of moles in 5.4 g of glucose $= \frac{5.4\ \cancel{g}}{180\cancel{g}} = 0.03$

Number of molecules in 5.4 g of glucose $= 0.03x6.023x10^{23}$

$= 1.807x10^{23}$ molecules

1.39 a) 4 moles of HNO_3 gives 1 mole of $Cu\ (NO_3)_2$

$\therefore$ 1 mole " " " $\frac{1}{4}$ mole " "

= 0.25 mole.

b) 1 mole of Cu gives 2 moles of NO_2

0.5 " " " 2 x .05 moles = 1 mole of N_2

1.40 6.02×10^{23} atoms of Fe weight 55.8 gm

$\therefore$ 1 " " " $\frac{55.8}{6.02 \times 10^{23}}$ gm

$= 9.2 \times 10^{-23}$ gm

1.41 Number of moles of sodium present in 1.15 gm = $\frac{1.15}{23}$

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$ $= .05$

According to this equation -

$\therefore$ 2 moles of sodium give 1 mole of hydrogen

$\therefore$ .05 moles of sodium will give $\frac{1 \times .05}{2}$

$= .025$ moles.

1.42 $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

The amount of HCl being less than what is needed to react completely with Zn, it is the amount of HCl that will control the reaction.

2 moles of hydrochloric acid gives 1 mole of hydrogen

1.5 moles of hydrochloric acid will give $\frac{1 \times 1.5}{2}$

Zinc metal was left out unreacted. $= 0.75$ moles

1.43 Silver nitrate reacts with sodium chloride according to equation --

$AgNO_3 + NaCl$ ---- $AgCl + NaNO_3$

1 mole 1 mole 1 mole

0.1 mole 0.1 mole 0.1 mole

The amount of silver nitrate present being less than that of sodium chloride it will react completely. So we need to calculate the number of moles of AgCl formed by the reaction if 0.1 mole of AgNO .1 mole of $AgNO_3$ gives 1 mole of silver chloride. Therefore 0.1 mole of $AgNO_3$ will give 0.1 mole of silver chloride.

1.44 Calcium carbonate decomposes according to following equation :

$CaCO_3$ ------ $CaO + CO_2$

40+12+3x16 22.4 lit at STP

100.

22.4 lit of carbon dioxide is obtained from 100g $CaCO_3$

0.112 lit of carbon dioxide is obtained from $= \frac{100 \times 112}{22.4}$

$= 0.5$ gm

Number of the mole of CO_2 in .112 L

$= \frac{.112 \cancel{L}}{22.4} \times 6.023 \times 10^{23}$ molecules$\cancel{L}^{-1}$

$= 3.01 \times 10^{21}$ molecules

1.45 Mass of 1 mole of sugar ($C_{12}H_{22}O_{11}$)

= 12x12+22x1 + 11x16

= 144+22+176

= 342 g

Cost of (1 mole) 342 g of sugar = Rs.2.03

Cost of 1 kg (1000g) of sugar = $\frac{2.03 \times 1000}{342}$

= $\frac{2030}{342}$

= Rs.5.93 per kg.

Mass of 1 mole of common salt ($NaCl$) = 23+35.5

= 58.5

Cost of 55.8 g (1 mole) of common salt is Rs.0.07

Cost of 1 kg (1000g) of common salt will be = $\frac{0.07 \times 1000}{58.5}$

= $\frac{70}{58.5}$

= Rs.1.19 per kg.

1.46 Molecular mass of $Fe_2\,(SO_4)_3$ is $2x55.8+3(32+4x16)$

$= 111.6+3x96$

$= 111.6+288$

$= 399.6$

% of Fe in $Fe_2\,(SO_4)_3$ $= \frac{2x55.8x100}{399.6}$

$= \frac{11160}{399.6} = 27.93$

% of S in $Fe_2\,(SO_4)_3$ $= \frac{3x32x100}{399.6} = 24.02$

% of O in $Fe_2(SO_4)_3$ $= \frac{12x16x100}{399.6} = \frac{19200}{399.6}$

$= 48.05$

1.47 Number of mole of HCl in $100 cm^3$ of 2M HCl

$= (0.1\ lit)x\ (2\ \frac{mol}{lit}) = 0.2$ mole

Number of moles of HCl in $150\ cm^3$ of 3M HCl

$= (0.15\ lit)\ x\ (3\ \frac{mol}{lit}) = 0.45$ mole

Total number of moles of HCl $= 0.2 + 0.45$

$= 0.65$

Total volume of mixing two sample of HCl $= 0.1+0.15$

$= 0.25$ lit

Final concentration $= \frac{0.65}{0.25} = \frac{65}{25} = 2.5$ M

1.48 7 gm of Nitrogen $= \frac{7.0 \text{ gm}}{14.0 \text{ gm/gm atom}} = 0.50$ gm atom

1.0 gm of hydrogen $= \frac{1.0 \text{ gm}}{1.008 \text{ gm/gm atom}} = 1.0$ gm atom.

∴ the simplest formula of the compound is

$N_{0.50} H_{1.0}$ or NH_2 .

1.49 3.0115×10^9 molecules weigh 1.0×10^{-12} gm.

∴ 6.02×10^{23} " " " $\frac{1.0}{3.0115} \times 6.02 \times \frac{10^{-12} \times 10^{23}}{10^9}$ gm

$= 2 \times 10^2 = 200$ gm.

The molecular weight is therefore 200.

1.50 100% 39K would mean 6.02×10^{23} atoms of 39K

$\therefore$ 93.2% 39K " " $\dfrac{6.02 \times 10^{23}}{100} \times 93.2$

$= 6.02 \times 93.2 \times 10^{21}$

$= 561 \times 10^{21} = 5.61 \times 10^{23}$ atom of 39K.

1.51 a) 22400 cm^3 of hydrogen at STP has 6.02×10^{23} molecules

$\therefore$ 224 cm^3 " " " " $\dfrac{6.02 \times 10^{23}}{100}$

$==$ 6.02×10^{21} molecules

b) 28 gm of nitrogen at STP has 6.02×10^{23} molecules

c) 32 gm of $_2$ at STP has $\dfrac{6.02 \times 10^{23}}{10} = 6.02 \times 10^{22}$ molecules

d) 12 gm of carbon has 6.02×10^{23} molecules

$\therefore$ 4.8 gm " " $\dfrac{6.02 \times 10^{23}}{12} = 4.8$ molecules

$= 2.408 \times 10^{23}$ molecules.

$\therefore$ b) has the largest number of molecules.

SOLUTIONS OF NUMERICAL PROBLEMS

UNIT : 3

STATES OF MATTER

3.51 Total volume = $(1 + 4)\,m^3 = 5\ m^3$.

Consider the pressure that the hydrogen would exert if it alone occupied the total volume of $5\ m^3$. For hydrogen ,

P_1 = 202.6 kPa. P_2 = ?

V_1 = $1\ m^3$ V_2 = $5\ m^3$.

by Boyle's law,

$$202.6\ kPa \times 1\ m^3 = P_2 \times 5\ m^3.$$

$$P_2 = \frac{202.6\ kPa \times 1\ \cancel{m}^3}{5\ \cancel{m}^3} = 202.6 \times \frac{1}{5}\ kPa.$$

This is the partial pressure of hydrogen.

Now let us consider the pressure that nitrogen would exert alone, if it occupies $5\ m^3$ volume

For nitrogen,

P_1 = 101.3 kPa. P_2 = ?

V_1 = $4\ m^3$ V_2 = $5\ m^3$.

∴ by Boyle's law,

$$101.3 \text{ kPa} \times 4 \text{ m}^3 = P_2 \times 5 \text{ m}^3$$

$$P_2 = \frac{101.3 \text{ kPa} \times 4 \cancel{m^3}}{5 \cancel{m^3}} = 101.3 \times \frac{4}{5} \text{ kPa.}$$

This is the partial pressure of nitrogen.

a) From the above calculations, it is clear that nitrogen gas has a higher partial pressure.

Now by Dalton's law,

Total pressure = partial pressure of hydrogen +
partial pressure of nitrogen

b) ∴ Total pressure $= \left(\frac{2}{5} + \frac{4}{5}\right) 101.3$ kPa

$$= \frac{6}{5} \times 101.3 \text{ kPa}$$

$$= 1.2 \times 101.3 \text{ kPa}$$

$$= \underline{121.56 \text{ kPa}}$$

3.52 Let the moles of CO_2 present/dm^3 of gas at 323 K and 101.3 kPa be n

$$PV = nRT$$

$$\therefore \quad n = \frac{PV}{RT}$$

$$= \frac{101.3\ k\cancel{P}a \times 1\ d\cancel{m}^3}{8.31\ k\cancel{P}a\ d\cancel{m}^3\ mol^{-1}\ \cancel{K^{-1}} \times 323\ \cancel{K}}$$

$$= \frac{101.3}{8.31 \times 323}\ mol.$$

$$= 0.039\ mol$$

molar mass of $CO_2 = 44 \times 10^{-3}$ kg mol^{-1}

$\therefore$ mass of total moles of CO_2 in 1 dm^3 is

44×10^{-3} kg $mo\cancel{l}^{-1} \times 0.039\ m\cancel{o}l$

$= 1.716 \times 10^{-3}$ kg.

$\therefore$ mass of number of mol of CO_2 in 1 m^3 is 1.716 kg.

$\therefore$ density $= 1.716$ kg/m^3

3.53 22.4 dm^3 at STP weigh 1 molar mass

0.57 dm^3 . . . . $\frac{0.56\ \cancel{dm}^3}{22.4\ \cancel{dm}^3}$ moles

$\therefore$ $\frac{0.56}{22.4}$ mole weighs 0.0015 kg = 1.5 x 10^{-3} kg.

$\therefore$ molecular mass is = $\frac{1.5 \times 10^{-3}\ kg \times 22.4\ \cancel{dm}^3}{0.56\ \cancel{dm}^3}$

= 0.060 kg

= 60 g.

3.54 Density = $\frac{\text{mass of 1 mol}}{\text{vol of 1 mol}}$

1 mol occupies 22.4 dm^3 at STP.

$\therefore$ first the volume of CH_4 has to be determined at STP.

P_1 = 101.325 kPa. P_2 = 215.325

V_1 = 22.4 dm^3 V_2 = ?

T_1 = 273 K T_2 = 293 K.

$$\frac{P_1\ V_1}{T_1} = \frac{P_2\ V_2}{T_2}$$

$$\therefore \quad \frac{101.325 \text{ kPa} \times 22.4 \text{ dm}^3}{273 \text{ K}} = \frac{505.325 \text{ kPa} \times V_2 \text{ dm}^3}{393 \text{ K}}$$

$$\therefore V_2 \text{dm}^3 = \frac{22.4 \text{ dm}^3 \times 101.325 \text{ k}\cancel{\text{P}}\text{a} \times 393 \cancel{\text{K}}}{505.325 \text{ k}\cancel{\text{P}}\text{a} \times 273 \cancel{\text{K}}}$$

$$\therefore \quad \frac{22.4 \times 101.325 \times 393}{505.325 \times 273} \text{ dm}^3 \text{ weigh } 16 \times 10^{-3} \text{ kg.}$$

$$\therefore \quad \text{density is } 16 \times \frac{505.325 \times 273 \times 10^{-3}}{22.4 \times 101.325 \times 393} \frac{\text{kg}}{\text{dm}^3}$$

$$= \frac{16 \times 5 \times 273}{22.4 \times 393} = 0.24 \times 10^{-3} \text{ kg/dm}^3$$

$$= 0.24 \times \frac{\cancel{10^{-3}} \text{ kg}}{\cancel{10^{-3}} \text{ m}^3} = 0.24 \text{ kg/m}^3$$

3.55 $\quad 22.4 \text{ dm}^3$ at STP contain 6.02×10^{23} molecules

$$\therefore \quad 1 \times 10^{-3} \text{ dm}^3 \quad " \quad \frac{6.02 \times 10^{23} \times 10^{-3}}{22.4} \text{ molecules}$$

$$= 2.69 \times 10^{19} \text{ molecules.}$$

3.56 Density is $\frac{\text{mass}}{\text{volume}}$

$\therefore$ 1 m^3 of He weighs 0.1784 kg.

$$\therefore 22.4 \times 10^{-3}\ m^3 \quad " \quad \frac{0.1784\ kg \times 22.4 \times 10^{-3}\ \cancel{m^3}}{1\ \cancel{m^3}}$$

$$= 3.9996 \times 10^{-3}\ kg.$$

since $22.4 \times 10^{-3}\ m^3$ of He at STP is the volume of 1 mol of He

$\therefore$ weight of 1 mole of He is 3.996×10^{-3} kg

$$= 3.996\ g.$$

3.57 For comparing the [illegible] the volume of the gas in offer b) is converted to STP

$V_1 = 10\ dm^3$. $\qquad V_2 = ?$

$P_1 = 1.3$ kPa $\qquad P_2 = 101.325$ kPa

$T_1 = 423$ K $\qquad T_2 = 273$ K

$$\frac{1.3\ kPa \times 10\ dm^3}{423\ K} = \frac{101.325\ kPa \times V_2}{273\ K}$$

$$\therefore \quad V_2 = \frac{1.3\ \cancel{kPa} \times 10\ dm^3 \times 273\ \cancel{K}}{101.325\ \cancel{kPa} \times 423\ \cancel{K}} = 82 \times 10^{-3}\ dm^3$$

Therefore for the same price the first offer of $0.1\ dm^3$ is better.

3.58 18×10^{-3} kg of H_2O is contained in 1 mol of H_2O.

$$\therefore\ 40 \times 10^{-3}\ kg \quad " \quad " \quad \frac{1\ mole}{18 \times 10^{-3}\ \cancel{kg}} \times \frac{40 \times 10^{-3}\ \cancel{kg}}{1}$$

$$= \frac{40}{18}\ mol = 2.22\ mol$$

5.85×10^{-3} kg of NaCl is contained by 1 mol of H_2O of NaCl.

$$\therefore\ 60 \times 10^{-3}\ kg \quad " \quad " \quad " \quad \frac{1\ mol \times 60 \times 10^{-3}\ \cancel{kg}}{58.5 \times 10^{-3}\ \cancel{kg}}$$

$$= \frac{60}{58.5}\ mol = 1.03\ mol$$

$\therefore$ there are more molecules of H_2O.

3.59 We know,

$$RT = \frac{1}{3} Nmu^2$$

(Here T is temperature in Kelvin, R gas Constant, N number, of molecules m is mass of a molecule, u is average kinetic energy).

$$u^2 = \frac{3\ RT}{Nm}$$

If one considers one mole of the gas $Nm = \bar{m}$ (molar mass)

$$u^2 = \frac{3\ RT}{\bar{m}}$$

Here, $\bar{m} = 32 \times 10^{-3}$ kg mol^{-1}, $R = 8.31$ kg m^{2}s^{-2} K^{-1},

$T = 300$ k

$$u^2 = \frac{3 \times 8.31\ \cancel{kg}\ m^2 s^{-2}\ \cancel{K}^{-1}\ \cancel{mol}^{-1}\ 300\ \cancel{K}}{32 \times 10^{-3}\ \cancel{kg}\ \cancel{mol}^{-1}}$$

$$= \frac{3 \times 8.31\ m^2 s^{-2}}{32 \times 10^{-3}}$$

$u = 484$ ms^{-1}

3.60 Since the final volume of the gases remains the same, total pressure will be the sum of the pressures of the gases

i.e. $P = p_1 + p_2$ where P is the total pressure, and p_1 and p_2 are the individual pressures of gas x and y.

$\therefore P = 20.65$ kPa + 40.53 kPa.

$= 61.18$ kPa.

3.61 We know that the average atmospheric pressure (total pressure) at the sea level is 101.325 kPa. Also, partial pressure = mole fraction x total pressure

Partial pressure of nitrogen = 0.781 x 101.325 kPa

= 79.1 kPa.

Partial pressure of oxygen = 0.209 x 101.325 kPa.

= 21.17 kPa.

Partial pressure of argon = 0.009 x 101.325 kPa

= 0.9 kPa.

3.62 Attributing excess of ΔH of sublimation of ice, above that of a non hydrogen bonded solid, to hydrogen bonding, ΔH (hydrogen bond)

$$= \frac{57.0 \text{ kJ/mol} - 15.2 \text{ kJ/mol of } H_2O}{2 \text{ mol H bond/mol of } H_2O} = \frac{35.5 \text{ kJ/mol of}}{2} \text{ H bond}$$

$$= 17.7 \text{ kJ/mol of H - bond.}$$

3.63 6.02×10^{23} molecules of H_2SO_4 are contained in 1 mol of H_2SO_4

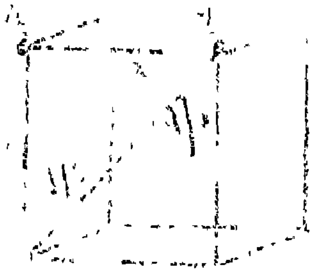
$$\therefore \; 1 \; '' \quad \text{in} \quad \frac{1 \text{ mol}}{6.023 \times 10^{23} \text{ molecules}}$$

$$\therefore \; 2 \times 10^{18} \text{ molecules} \quad \frac{1 \text{ mol} \times 2 \times 10^{18} \text{ molecules}}{6.023 \times 10^{23} \text{ molecules}}$$

$$= \frac{2}{6.23} \times 10^{-5} \text{ mol}$$

$$= 3.3 \times 10^{-3} \text{ millimol}$$

3.64 Using pythogoras' theorem, for the triangle ABC,



$$d^2 = 2a^2$$

$$d = a\sqrt{2}$$

In the face centred cubic structure, the closest distance between 2 gold atoms is the distance between gold atom of the face centered position and that at the corner position.

This distance is $\frac{d}{2} = \frac{1}{2}a\sqrt{2} = \frac{a}{\sqrt{2}} = \frac{4070\text{ pm}}{\sqrt{2}} = 2878\text{pm}$

3.65 Density of Al being $2.70 \times 10^{+3}$ kg/m^3

$2.70 \times 10^{+3}$ kg of Al occupies 1 m^3

$\therefore$ 27×10^{-3} kg " " $\frac{1\text{ m}^3 \times 27 \times 10^{-3}\ \cancel{\text{k}}\text{g}}{2.70 \times 10^{+3}\ \cancel{\text{k}}\text{g}}$

$= 10 \times 10^{-6}$ m^3.

$\therefore$ 1 mol of Al has a volume of 10×10^{-6} m^3.

This volume will have Avagadro number of aluminium atom.

$\therefore$ volume of 6.023×10^{23} atom of Al is $10 \times 10^{-6}\ m^3$

$$\therefore \quad " \quad 1 \text{ atom} \quad " \quad " \quad \frac{10 \times 10^{-6}\ m^3}{6.023 \times 10^{23}}$$

Since 25.9% is void,

100 - 25.9 = 74% is packed.

Let the diameter of the sphere be d.

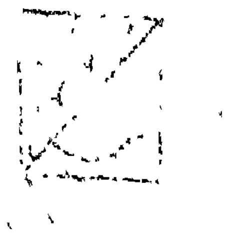
$$\therefore \frac{4}{5}\pi\left(\frac{d}{2}\right)^3 = \frac{0.741 \times 10 \times 10^{-6}\ m^3}{6.023 \times 10^{23}}$$

$$\text{or} \quad \left(\frac{d}{2}\right)^3 = \frac{7.41 \times 10^{-6}}{1.33 \times 3.14 \times 6.023 \times 10^{23}} \times m^3.$$

$$\therefore d = 1.43 \times 10^{-10}\ m$$

$$= 143\ pm.$$

3.66



According to the figure, atoms tough along the face diagonal d_f.

$\therefore$ if the radius of the Ag atom is r, then, $d_f = 4r$

$= 4 \times (144.5\ pm) = 578.0\ pm.$

The edges "a" of the unit cell being the arm of a right triangle with hypotenus d_f, using the pythogorous theorem, one gets,

$$d_f^2 = 2a^2 \qquad a^2 = \frac{1}{2} d_f^2 = 578 \text{ pm}$$

$$a = \frac{1}{\sqrt{2}} d_f = \frac{578.0}{\sqrt{2}} \text{ pm}$$

$$= 408.7 \text{ pm.}$$

3.67 According to Bragg's law,

$$n\lambda = 2d \sin\theta .$$

using n = 1, first order differaction only,

we got,

$$\sin\theta = \frac{n\lambda}{2d} = \frac{1 \times 154 \text{ pm}}{2 \times 397 \text{ pm}} = 0.1940.$$

$$\therefore \quad \theta = \text{arc sin } 0.1940 = 11.18^\circ .$$

NOTE : Diffraction angle will also be observed at n = 2, and in that case, a similar calculation will be required.

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT : 4

ATOMIC STRUCTURE

4.80 Wavelength n and frequency of a wave are related by the equation :

$$\lambda = \frac{C}{\nu} \text{ where C is the velocity of light.}$$

$$\nu = \frac{C}{\lambda} = \frac{3 \times 10^{8} \cancel{m} s^{-1}}{420 \cancel{m}} = \frac{1}{140} \times 10^{8}\ S^{-1}$$

$= 0.714 \times 10^{6}$ Hertz.

714 Kilo Hertz.

4.81 For 100 atoms of Cu, the total mass would be :

$$69.09\ \text{a}\cancel{\text{t}}\text{om} \times 62.93\ \frac{\text{amu}}{\text{a}\cancel{\text{t}}\text{om}} + 30.91\ \text{at}\cancel{\text{o}}\text{m} \times 64.39\ \frac{\text{amu}}{\text{a}\cancel{\text{t}}\text{om}}$$

= 6355 amu/100 atom

$\therefore$ atomic weight of Cu is 63.38 amu.

4.82 The shortest wavelength transition would correspond to the highest frequency and to the highest energy. The transition would thus be from the lowest energy state (i.e. ground state) for which n = 1 to the highest for which n = ∞

$$\bar{\nu} = R\left(\frac{1}{1^{2}} \quad \frac{1}{\infty^{2}}\right)$$

$$= 109677\ \text{cm}^{-1}$$

$$\therefore \lambda = \frac{1}{109677} \text{ cm} = 0.9117 \times 10^{-7} \text{ cm}$$

$$= 91.17 \times 10^{-9} \text{ m}$$

$$= 91.17 \text{ nm.}$$

4.83 The frequency ν is related to the wavelength by the expression :

$$\nu = \frac{C}{\lambda} \quad \text{where } C \text{ is the velocity of light}$$

$$\therefore \nu = \frac{3 \times 10^{8} \cancel{m}s^{-1}}{450 \times 10^{-9} \cancel{m}} = 6.7 \times 10^{14} \text{ Hz.}$$

4.84 $$\bar{\nu} \text{ cm}^{-1} = 109677 \left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

$$= 109677 \left(\frac{1}{4} - \frac{1}{16}\right)$$

$$= 109677 \times \frac{3}{16}$$

$$\therefore \lambda \text{ cm} = \frac{16}{3 \times 109677} = 486 \times 10^{-7} \text{ cm}$$

$$= 486 \times 10^{-9} \text{ m}$$

$$= 486 \text{ nm.}$$

4.85 Kinetic energy of electrons

$$= h\nu - h\nu_{crit} = \frac{hc}{\lambda} - \frac{hc}{\lambda_{crit}} = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_{crit}}\right]$$

$$= (6.63\times10^{-34}\ \mathrm{J}\cancel{\mathrm{s}})\ (3.00\times10^{8}\ \mathrm{m}\cancel{\mathrm{s}}^{-1})\ \left[\frac{1}{4} - \frac{1}{6}\right] \times 10^{-7}\ \mathrm{m}]^{-1}$$

$$= \frac{6.63 \times 3}{12} \times 10^{-19}\ \mathrm{J}$$

$$\frac{6.63}{4} \times 10^{-19}\ \mathrm{J}.$$

$$= 1.65 \times 10^{-19}\ \mathrm{J}.$$

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT - 5

CHEMICAL FAMILIES - PERIODIC PROPERTIES

5.57 density of C is $\frac{12 \times 10^{-3}\ kg}{5 \times 10^{-6}\ m^3} = 2.4 \times 10^{+3}\ kg/m^3$

density of N is $\frac{14 \times 10^{-3}\ kg}{14 \times 10^{-6}\ m^3} = 1 \times 10^{+3}\ kg/m^3$

5.58 $M \longrightarrow M^+ + e^- - 367$

$x + e^- \longrightarrow x^- + I.P.$

$M + X \longrightarrow M^+ + X^- - 367 + I.P.$

But heat absorbed in the reaction

$M + X \longrightarrow M^- + X^-$ is 255 kJ.

$IP - 367 = -255$ kJ.

or $IP = 112$ kJ.

5.59 $Na + 496 = Na^+ + e^-$

$Cl + e^- = Cl^- + 348$

$Na + Cl \longrightarrow Na^+ + Cl^- - 148$ kJ.

Energy absorbed in the reaction is 148 kJ.

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT - 6

Bonding and Molecular Structure

6.57 a) For complete transfer of electron (i.e. 100% ionic character), the dipole moment of NaCl molecule

$$= (1.60 \times 10^{-19} C) \times (0.283 \times 10^{-9} m).$$

$$= 4.528 \times 10^{-29} Cm.$$

b) Direction of dipole moment is $\overrightarrow{\text{NaCl}}$

6.58 Let us calculate the dipole moment of a hypothetical, fully ionised Li^+H^- ion pair with a separation of 1.596×10^{-10} m.

Dipole moment (hypothetical) $= (1.602 \times 10^{-19} C)(1.596 \times 10^{-10} m)$

$$= 2.557 \times 10^{-29} C.m.$$

The fractional ionic character is the actual dipole moment divided by the hypothetical dipole moment.

$$\therefore \text{ fractional ionic character} = \frac{1.964 \times 10^{-29} C.m.}{2.557 \times 10^{-29} C.m.}$$

$$= 0.768.$$

$\therefore$ the bond is 76.8 % ionic.

SOLUTION OF NUMERICAL PROBLEMS

UNIT : 8

ENERGETICS

8.98 $H = (H)_{\text{Products}} - (H)_{\text{recatents}}$

for the reaction:

$CO_2(g) + H_2(g)$ ------ $CO(g) + H_2O\ (g)$

$H = (H_{CO} + H_{H_2O}) - (H_{CO_2} + H_{H_2})$

$= -110.5 + (-241.8) - (-393.8 + 0)$

$= -352.3 + 393.8$

$= 41.5$ kJ

Heat of reaction = 41.5 kJ.

8.99 The reactions are :

a) $C_2H_5OH(l) + 3O_2(g) \text{ ---- } 2CO_2(g) + 3H_2O(l)$,

$H = -1380$ kJ.

b) $C(s) + O_2(g) \text{ --- } CO_2(g)$; $H = -396$ kJ

c) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$; $H = -287$ kJ.

We have to manipulate equations a,b,c in such a way as to get the required equation :

d) $2C(s) + 3H_2(g) + \frac{1}{2} O_2(g) \text{ ---- } C_2H_5OH(l)$;

$H = ?$

Multiplying eqn. (b) by 2 and eqn. (c) by 3 and adding we get :

$$2C + 3H_2 + \frac{7}{2}O_2 \text{ ----} \rightarrow 2CO_2 + 3H_2O$$

Subtracting eqn. (a) from the above eqn. we have

$$2C + 3H_2 + \frac{1}{2} O_2 \text{ ----- } C_2H_5OH$$

This is same as equation d).

∴ The required $H = 2(-396)+3(-287)-(-1380)$ kJ or $H = -273$ kJ.

8.100 Let x be the heat of formation of ethene. The eqn. is

$2C(s) + 2H_2(g) \text{ ----}\rightarrow C_2H_4(g)$; $H = x$

∴ H = enthalpy of products - enthalpy of reactants

further eqn. (c) gives heat of combustion of ethene and remembering that enthalpy of $O_2(g)$ by convention is zero, we have

$$\Delta H = (2H_{CO_2} + 2H_{H_2O}) - (H_{C_2H_4} + 3H_{O_2}) .$$

Substituting enthalpies of CO_2 and H_2O from equation a) and b) in above equation, we have ,

$$\Delta H = -1400 - [\, 2 \times (-396) + 2 \times (-287) - (0) \,]$$

$\therefore \Delta H$ or $= -34$ kJ.

8.101 The equation for the heat of formation of ethanoic acid can be written as

$$2C(s) + 2H_2(g) + O_2(g) \longrightarrow CH_3COOH(l) ;$$

$\Delta H =$? (equation iv)

Multiplying equation (i) by 2 equation (ii) by 2 and subtracting equation (iii) we get the required equation (iv).

$\therefore$ the heat evolved in the formation of ethanoic acid is :

$(2 \times 394.8) + (2 \times 285.6) - 882$ kJ

$= (789.6 + 571.2 - 882)$ kJ.

$= (1360.8 - 882)$ kJ.

$= 478.8$ kJ

or $\Delta H = -478.8$ kJ.

8.102 $\Delta G = \Delta H - T\Delta S$.

for a reversible reaction at equilibrium, $\Delta G = 0$

$\therefore 0 = 5.99 - (273 \times \Delta S)$

$273\ \Delta S = 5.99$

$$\Delta S = \frac{5.99}{273\ K}\ kJ\ mol^{-1}$$

$$\Delta S = \frac{5.99}{273} \times 1000 = 21.9\ J\ mol^{-1}\ K^{-1}$$

$\therefore$ (a) $\Delta G = 0$ (b) $\Delta S = 21.9\ JK^{-1}\ mol^{-1}$

8.103 $\Delta G = \Delta H - T\Delta S$

$\Delta G = 0$ for a reversible reaction at equilibrium

$0 = \Delta H - T\Delta S$

$\therefore 0 + T\Delta S = \Delta H$

$373\ \Delta S = 40.62\ kJ\ mol^{-1}$

$$\Delta S = \frac{40.62 \times 1000}{373} = 108.9\ J\ mol^{-1}\ K^{-1}$$

(a) $\Delta G = 0$ (b) $\Delta S = 108.9\ JK^{-1}\ mol^{-1}$

8.104 $1 m^3$ of C_2H_4 at STP is 1000 L of C_2H_4 at STP.

22.4 L of C_2H_4 at STP has 1 mole of C_2H_4 at STP

$$\therefore 1000 \text{ L} \quad '' \quad '' \quad '' \quad 1 \text{ mole} \times \frac{1000 \cancel{\text{L}}}{22.4 \cancel{\text{L}}} \text{ at STP}$$

$$= 44.6 \text{ mol at STP.}$$

$\therefore$ heat change from the given reaction is

$$44.6 \text{ m}\cancel{\text{o}}\text{l} \times (-1410) \frac{\text{kJ}}{\text{m}\cancel{\text{o}}\text{l}}$$

$$= -62886 \text{ kJ.}$$

$\therefore$ the useful heat is :

$$(0.70)\ (62886 \text{ kJ}) = 44020.2 \text{ kJ}$$

$$= 44.02 \times 10^3 \text{ kJ.}$$

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT - 9

CHEMICAL EQUILIBRIUM

9.63 $K_p = K_c \; (RT)^{\Delta n}$

$$CO_2\,(g) + H_2\,(g) \rightleftharpoons CO\,(g) + H_2O\,(g).$$

$$\Delta n = 0$$

$$\therefore \; K_p = K_c = (RT)^0$$

$$K_p = K_c = 1.6$$

9.64 $2\,HI\,(g) \rightleftharpoons H_2\,(g) + I_2\,(g)$

Immediately after injecting the HI to the container, its concentration is

$$\frac{1.00 \text{ mol}}{5.00 \text{ L}} = 0.200 \text{ mol L}^{-1} = 0.200 \text{ M.}$$

At the same time the initial concentration of H_2 and I_2 are both 0. The reaction proceeds forward, increasing HI until the equilibrium condition is met.

Let x be the increase in the concentration of H_2 necessary to reach equilibrium. Then x is also equal to the increase in the concentration of I_2.

The decrease in the concentration of HI is 2x, because 2 moles of HI are used to make 1 mole each of H_2 and I_2.

Thus at equilibrium, the concentration of HI is (2.00 - 2x), that of H_2 is x and that of I_2 is x. The equilibrium condition is

$$\frac{H_2 \quad I_2}{HI} = K_{eq} \quad \frac{(x)\ (x)}{(0.200-2x)^2} = 2.06 \times 10^{-2}$$

$$\frac{x^2}{(0.200-2x)^2} = 2.06 \times 10^{-2}$$ .Taking square root

$$\frac{x}{0.200-2x} = 1.44 \times 10^{-1}$$

Solving for x, $x = 2.24 \times 10^{-2}$

At equilibrium therefore

$$[H_2] = x = 2.24\times10^{-2} \text{ mol L}^{-1}$$

$$[I_2] = x = 2.24\times10^{-2} \text{ mol L}^{-1}$$

$$[HI] = 0.200 - 2x$$

$$= 0.155 \text{ mol L}^{-1}$$

9.65 Let the extent of esterification be x. Then,

$$\text{HAc} + \text{EtOH} \qquad \text{EtAc} + H_2O$$

$$(1-x) \quad (1-x) \quad x \qquad x$$

$$K = \frac{x^2}{(1-x)^2} \quad \text{or} \quad 4 = \frac{x^2}{(1-x)^2}$$

Taking square root of both sides,

$$2 = \frac{x}{1-x}$$

or $2 - 2x = x$ or $2 = 3x$ or $x = \frac{2}{3} = 0.667.$

9.66 $2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g)$

Let K_5 represent the equilibrium constant when the reaction vessel is a 5 L flask, and K_{10} when in a 10 L flask.

$$K_5 = \frac{[SO_3]^2}{[SO_2]^2\,[O_2]} = \frac{\left(\frac{0.85}{5}\right)^2}{\left(\frac{0.15}{5}\right)^2 \left(\frac{0.58}{5}\right)}$$

$$= 2.8 \times 10^2$$

and $$K_{10} \quad \frac{\left(\frac{0.68}{10}\right)^2}{\left(\frac{0.32}{10}\right)^2 \left(\frac{0.16}{10}\right)} = 2.8 \times 10^2$$

∴ the equilibrium constant remain the same irrespective of the volume of the reaction flask .

9.67 First we find the value of the concentration quotient

$$Q = \frac{[SO_2]^2\,[O_2]}{[SO_3]^2}$$

$$= \frac{(0.15)^2\ (0.025)}{(0.60)^2} = 1.6 \times 10^{-3}$$

Since this is less than the value of the equilibrium constant 4.8×10^{-3}, the reaction proceeds to the right so that SO_2 increases, O_2 increases and SO_3 decreases, until $Q = K$.

9.68 NaOH is a strong base. Ignoring the negligible contribution made to $[OH^-]$ by the dissociation of water, we can say that $[OH^-] = 0.016\ M = 1.6 \times 10^{-2}\ M$.

Then $pOH = -\log\ (1.6 \times 10^{-2})$

$= 1.80$

To find pH we have a choice of 2 methods :

Method I : $[H^+][OH^-] = Kw$

$$[H^+] = \frac{Kw}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.6 \times 10^{-2}}$$

$$= 6.3 \times 10^{-13}\ M.$$

$pH = -\log\ (6.3 \times 10^{-13}) = 12.20.$

Method II :

$$pH + p^{OH} = 14$$

$$pH = 14 - pOH$$

$$= 14 - 1.80$$

$$= 12.20$$

9.69 $Kw = [OH^-][H_3{}^+O] = 10^{-7} \times 10^{-7}\ mol^2\ L^{-2}$

$$[H_3O^+] = (10^{-7} + 10^{-9})\ mol\ L^{-1}$$

$$= (10^2 \times 10^{-9} + 1 \times 10^{-9})\ mol\ L^{-1}$$

$$= 101 \times 10^{-9}\ mol\ L^{-1}$$

$$pH = -\log [H_3O^+]$$

$$= -\log 101 \times 10^{-9}$$

$$= -2.0043 + 9$$

$$= 6.9957$$

9.70 a) $HCl + H_2O \rightarrow H_3O^+ \quad Cl^-$

$$H_3O^+ = Cl^- = .03\ M$$

$$= .03\ mol\ L^{-1}$$

$$K_w = [H_3O^+][OH^-] = 1.0\times10^{-14}\ mol^2\ L^{-2}$$

$$\therefore \frac{1.0\times10^{-14}\ mol^2\ L^{-2}}{[H_3O^+]} = [OH^-]$$

$$\therefore [OH^-] = \frac{1.0\times10^{-14}\ mol^{\cancel{2}}\ L^{-\cancel{2}}}{.03\ m\cancel{o}l\ \cancel{L}^{-1}} = 0.33\times10^{-12}\ mol\ L^{-1}$$

b) $K_w = [OH^-][H_3O^+]$

$[H_3O^+]$ of the solution is .03 mol L^{-1}

$$\therefore 51\times10^{-14}\ mol^2\ L^{-2} = [OH^-]\times .03\ mol\ L^{-1}$$

$$\therefore [OH^-] = \frac{51\times10^{-14}\ m\cancel{o}l^2\ \cancel{L}^{2}}{3\times10^{-2}\ m\cancel{o}l\ \cancel{L}^{1}}$$

$$= 17\times10^{-12}\ mol\ L^{-1}$$

9.71 $NH_4Cl + H_2O \dashrightarrow NH_4^+ + Cl^-$

(0.2 M) (0.2 M) (0.2 M)

NH_4Cl being a strong electrolyte, completely dissociates in water

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

(0.4-x) M x M x M

NH_3 is a weak base, let x M be the number of moles of NH_3 in 1 litre which dissociates to establish equilibrium.

$\therefore$ total $NH_4^+ = (0.2 + x)$ M

$$K_b = \frac{NH_4^+ \quad OH^-}{NH_3} = \frac{(0.2 + x) \quad (x)}{(0.4 - x)}$$

assuming that x is very very small, x can be neglected in comparison to the concentration value.

$\therefore \; 0.2 + x \approx 0.2$ and $0.4 - x \approx 0.4$

$$\therefore \; Kb = 1.8 \times 10^{-5} = \frac{0.2\,x}{0.4}$$

or $1.8 \times 10^{-5} = \frac{1}{2}\,x$

or $x = 3.6 \times 10^{-5}$ mol L^{-1} = concentration of free OH^-

b) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$(0.4-x) \qquad x \qquad x$

$$Kb = 1.8 \times 10^{-5} = \frac{x^2}{0.4-x}$$

Since NH_3 is a weak base, x can be assumed to be very very small.

$$\therefore \quad K_b = \frac{x^2}{0.4}$$

$$\text{or } x^2 = (1.8 \times 10^{-5})(0.4)$$

$$= 0.72 \times 10^{-5}$$

$$\text{or } x = \sqrt{0.72 \times 10^{-5}}$$

$$= 2.7 \times 10^{-3} \text{ mol L}^{-1}$$

comparing this value of x with the value in a) above, we see that the addition of NH_4Cl reduce the production of $(OH)^-$ ion.

9.72 The equilibrium constant of all the reaction given must be met simultaneously, but since ethanoic acid is the strongest of these acids (as the K values show), we can ignore the contribution made by the HCN and H_2O to the hydrogen ion concentration. If we let x be the number of moles of CH_3COOH dissociated per litre, then at equilibrium, $[H^+] = x$; $[C_2H_3O_2^-] = x$;

$$[CH_3COOH] = 0.10 - x$$

$$\therefore \quad Ka = \frac{[H^+][C_2H_3O_2^-]}{[CH_3COOH]} = \frac{x \times x}{0.10-x} = 1.8 \times 10^{-5}$$

$$\text{or} \quad x = 1.3 \times 10^{-3}$$

$$[H^+] = x = 1.3 \times 10^{-3} \text{ M}$$

9.73 $[OH^-] = 2 \times 10^{-7}$ mol L^{-1}.

i.e. pOH = $\log_{10} [OH^-]$

$= -\log_{10} (2 \times 10^{-7})$

$= 6.699$

∴ = 14 − pOH = 7.301.

9.74 Kw (at 373 K) = 55 x Kw (at 298 K).

$= 55 \times 10^{-14}$ $mol^2 L^{-2}$

pH = $-\log_{10} H^+ = -\frac{1}{2} \log_{10} Kw$.

$= -\frac{1}{2} \log_{10} 55 \times 10^{-14}$

pH = 6.13

9.75 $PbSO_4$ (solid) Pb^{2+} + SO_4^{2-} (in water)

Expressing the concentration in mol L^{-1},

$$0.038 \text{ g L}^{-1} = \frac{0.038 \text{ g L}^{-1}}{303 \text{ g mol}^{-1}} = 1.25 \times 10^{-4} \text{ mol L}^{-1}$$

$$\therefore K_{sp} = Pb^{2+} \cdot SO_4^{2-}$$

$$= (1.25 \times 10^{-4})(1.25 \times 10^{-4}) = 1.5 \times 10^{-8}$$

9.76 $Pb(IO_3)_2 \rightleftharpoons Pb^{2+} + 2(IO_3^-)$ in solution

$K_{sp} = [Pb^{2+}][IO_3^-]^2$

Let the solubility of $Pb(IO_3)_2$ be x mol L^{-1}

Then, $[Pb^{2+}] = x$ and $[IO_3^-] = 2x$

$$\therefore \quad x(2x)^2 = 2.5 \times 10^{-13}$$

$$4x^3 = 2.5 \times 10^{-13}$$

$$x^3 = 62 \times 10^{-15}$$

$$x = 4.0 \times 10^{-5}$$

$\therefore$ Solubility is 4.0×10^{-5} mol L^{-1}.

9.77 The maximum $[OH^-]$ that can be present in the solution without precipitation of $Mg(OH)_2$ is to be determined first.

$$[Mg^{2+}][OH^-]^2 = 7.1 \times 10^{-12}$$

$$[OH^-] = \sqrt{\frac{7.1 \times 10^{-12}}{.0010}} = \sqrt{71 \times 10^{-10}} = 8.4 \times 10^{-5}$$

Now find the $[NH_4^+]$ obtained from NH_4Cl needed to repress the ionization of NH_3, so that the $[OH^-]$ will not exceed 8.4×10^{-5}.

$$\frac{[NH_4^+][OH^-]}{[NH_3]} = 1.75 \times 10^{-5} .$$

or, $$[NH_4^+] \times \frac{(8.4 \times 10^{-5})}{0.010} = 1.75 \times 10^{-5}$$

$$\therefore [NH_4^+] = 2.08 \times 10^{-3}$$

9.78 $Mg(OH)_2\,(s) \rightleftharpoons Mg^{2+} + 2\,(OH)^-$ in solution.

a) Let x be the number of moles of $Mg(OH)_2$ which dissolve per litre. Then,

$[Mg^{2+}] = x$ and $[OH^-] = 2x$.

Neglecting the OH^- from water, water being a weak electrolyte,

$$[Mg^{2+}][OH^-]^2 = K_{sp}$$

or $(x)\,(2x)^2 = 8.9 \times 10^{-12}$

or $4x^3 = 8.9 \times 10^{-12}$

or $x = 1.3 \times 10^{-4}$ M

The hydroxide ion concentration is

$[OH^-] = 2x = 2\ (1.3 \times 10^{-4})$

$= 2.6 \times 10^{-4}$ M.

b) pH = 12.

$\therefore [H^+] = 1.0 \times 10^{-12}$ M

$\therefore [OH^-] = \dfrac{K_w}{H^+} = \dfrac{1.0 \times 10^{-14}}{1.0 \times 10^{-12}} = 0.010$ M.

Let x be the number of moles of $Mg(OH)_2$ which dissolve per litre, then

$Mg\ (OH)_2\ (s) \rightleftharpoons Mg^{2+} + 2\ (OH)^-$ in solution

$[Mg^{2+}] = x.$

and at pH = 12,

$[OH^-] = (2x + 0.010).$

$\therefore K_{sp} = [(Mg^{2+})]\ [OH^-]^2 = (x)\ (2x + 0.010)^2 =$

$= 8.9 \times 10^{-12}$

Assuming 2x to be $\ll$ 0.010

$x\ (.010)^2 \simeq 8.9 \times 10^{-12}$

or $x \simeq 8.9 \times 10^{-8}$ M.

9.79 In NaI solution, $[I^-] = 1.4 \times 10^{-9}$ M and in $AgNO_3$ solution,

$$[Ag^+] = 7.9 \times 10^{-7} \text{ M.}$$

The final volume of the solution is

$(25 + 35) \times 10^{-3}$ L $= 60 \times 10^{-3}$ L.

$$\therefore [I^-]_{\text{final}} = 1.4 \times 10^{-9} \text{ M} \; \frac{25 \times \cancel{10^{-3}} \cancel{L}}{60 \times \cancel{10^{-3}} \cancel{L}} = 5.8 \times 10^{-10} \text{ M.}$$

$$[Ag^+]_{\text{final}} = 7.9 \times 10^{-7} \text{ M} \; \frac{25.0 \times \cancel{10^{-3}} \cancel{L}}{60.0 \times \cancel{10^{-3}} \cancel{L}} = 4.6 \times 10^{-7} \text{ M.}$$

The ion product is therefore,

$$[Ag^+][I^-] = (4.6 \times 10^{-7})(5.8 \times 10^{-10})$$

$$= 2.7 \times 10^{-16}.$$

This is greater than K_{sp} for AgI.

Therefore, there will be a precipitate of AgI.

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT - 10

REDOX REACTIONS

10.49 Since the electrons leave the cell from the hydrogen electrode, it must be the anode. The cell diagram and reaction are therefore ,

$\mathrm{Pt}\ (S)/H_2\ (g)\ H^+ \,||\, Cu^{2+}\ /Cu\ (s).$

Anode : $H_2\ (g) \longrightarrow 2\ H^+ + 2\ e^-$ $E^0 = 0$ (defined)

Cathode: $\underline{2e^- + Cu^{2+} \longrightarrow Cu\ (s)}$ $E^0 = ?$

Cell : $H_2\ (g) + Cu^{2+} \longrightarrow 2\ H^+ + Cu\ (s)$ $E^0 = 0.34$ V

(cell (measured)

since, E^0 cell $= E^0_R + E^0_L$

$\therefore\ 0.34 = E^0_{Cu^{2+}/Cu} - 0$

$E_{Cu^{2+}/Cu} = 0.34$ Volts

10.50 For the given cell,

oxidation : $2\ I^- \longrightarrow I_2 + 2\ e$ $E^0 = -.0.54$ V.

Reduction : $2\ e^- + Sn^{2+} \longrightarrow Sn\ (s)$ $E^0 = -.0.14$ V.

Redox : $Sn^{2+} + 2\ I^- \longrightarrow Sn(s) + I_2$ $E^0_{Cell} = -0.68.$

Since the total is negative, the reaction is non-spontaneous ($\therefore \Delta G = -nFE^{o}_{Cell}$ and with a negative value of E^{o}, ΔG will have a positive value. Therefore, it cannot occur . (The reverse reaction $I_2 + Sn\ (s) \rightarrow 2\ I^- + Sn^{2+}$ will have a E^{o}_{Cell} of + 0.68 V and will therefore be spontaneous).

10.51 The half cell reactions are :

Right : $\frac{1}{2}\ Cl_2\ (g) + e^- \rightarrow Cl^-(aq) \qquad E^{o}_{R} = 1.36\ V$

Left : $\frac{1}{2}\ Cu^{2+}\ (aq) + e^- \rightarrow \frac{1}{2}\ Cu\ (s) \quad E^{o}_{L} = 0.34\ V$

$$\therefore \quad E^{o}_{Cell} = E^{o}_{R} - E^{o}_{L} = 1.02\ V$$

$$E_R = E^{o}_{R} + \frac{RT}{2F} \ln \frac{[Cl_2]}{[Cl^-]^2}$$

$$E_L = E^{o}_{L} + \frac{RT}{2F} \ln \frac{[Cu^{2+}]}{[Cu]}$$

At equilibrium $E_R = E_L$

$$\therefore \quad E_R - E_L = \frac{RT}{2F} \ln \frac{[Cu^{2+}][Cl^-]^2}{[Cu][Cl_2]}$$

$$= \frac{RT}{2F} \ln \text{Kequil}$$

$$\therefore 1.02 = \frac{RT}{2F} \ln \text{Kequil.}$$

$$\log. K_{equil} = \frac{2 \times 1.02}{\left(2.303 \times \frac{RT}{F}\right)}$$

$$= \frac{2 \times 1.02}{0.059} = 34.68$$

$$\therefore \quad K_{equil} = 4.8 \times 10^{34}.$$

10.52 $$Ag^+ = \frac{K_{sp}}{[Cl]} = \frac{1.8 \times 10^{-10}}{1} = 1.8 \times 10^{-10} \text{ M}$$

This value of Ag^+ can be inserted into the Nernst equation for the Ag^+ / Ag half reaction.

$$E = E^o - \frac{0.0592}{1} \log \frac{1}{[Ag^+]}$$

$$= 0.799 - 0.592 \log \frac{1}{1.8 \times 10^{-10}}$$

$$= 0.799 - 0.576$$

$$= 0.223 \text{ V}.$$

10.53 The cell reaction is $Fe^{2+} + Ag^+ \rightleftharpoons Fe^{3+} + Ag$.

$$\therefore \quad E^o_{cell} = E^o (Ag^+/Ag) - E^o (Fe^{3+}/Fe^{2+})$$

$$= 0.799 - 0.771$$

$$= 0.028 \text{ V}.$$

from the Nernst equation

$$E = E^{o} - 0.0592 \log \frac{[Fe^{3+}]}{[Fe^{2+}][Ag^{+}]}$$

$$\therefore 0 = 0.028 - 0.0592 \log \frac{1}{[Ag^{+}]}$$

$$\therefore 0 = 0.028 + .0592 \log [Ag^{+}]$$

$$\therefore \log [Ag^{+}] = \frac{-0.028}{0.0592} = -0.47$$

$$\therefore [Ag^{+}] = 0.34 \text{ M}$$

10.54 Cell reaction is $Zn + Cu^{++} \rightarrow Zn^{++} + Cu$.

$$E = [E^{o}_{Cu} - E^{o}_{Zn}] + \frac{RT}{nF} \ln \frac{Cu^{+2}(aq)}{Zn^{+2}(aq)}$$

$$= [0.34-(-0.76)] + \frac{2.303\ RT}{nF} \log \frac{Cu^{+2}(aq)}{Zn^{+2}(aq)}$$

$$= 1.10 + \frac{2.303 \times 8.31 \times 298}{2 \times 96500} \log \frac{0.001}{0.1}$$

$$= 1.10 + \frac{0.059}{2} \log 10^{-2} = 1.10 - \frac{0.059 \times 2}{2}$$

$$= 1.10 - 0.059 = 1.041 \text{ V.}$$

10.55 $E^{o}_{Cell} = E^{o}_{Cathode} - E^{o}_{Anode}$

$= 0.77 - 0.15 = 0.62$ V

$G^{o} = - nE^{o}F$

$= - 2 \times 0.62 \times 96500$

$= - 119660$ J

10.56 Balanced cell reaction is:

$$2\ Cr + 3\ Fe^{+2} \longrightarrow 3\ Fe + 2\ Cr^{+3}$$

$$E_{Cell} = E^{o}_{Cell} + \frac{0.059}{6} \log \frac{[Fe^{+2}]^{3}}{[Cr^{+3}]^{2}}$$

$$= (E^{o}_{Cathode} - E^{o}_{Anode}) + \frac{0.059}{6} \log \frac{[Fe^{+2}]^{3}}{[Cr^{+3}]^{2}}$$

$$= -0.44 - (0.74) + \frac{0.059}{6} \log \frac{.01 \times .01 \times .01}{.01 \times .01}$$

$$= .30 + \frac{0.059}{6} \log 10^{-2}$$

$$= 0.30 + \frac{0.059}{6}(-2) = 0.30 - \frac{0.059 \times 2}{6}$$

$$= 0.30 - 0.0196 = +\ 0.2804\ V.$$

10.57 a) $0.34 - (-1.66) = 0.34 + 1.66 = 2.00$ V

b) $0.34 - (-0.44) = 0.34 + 0.44 = 0.78$ V

c) $2.87 - (-1.66) = 2.87 + 1.66 = 4.53$ V

d) . $2.87 - (-0.44) = 2.87 + 0.44 = 3.31$ V.

10.58 $E_{Cell} = E_R - E_L = E_{Ag} - E_{Ni}$

$$= E^o_{Ag} + \frac{RT}{2F} \ln [Ag^+]^2 - E^o_{Ni} + \frac{RT}{nF} \ln [Ni^{2+}]$$

$$= (E^o_{Ag} - E^o_{Ni}) + \frac{RT}{2F} \ln \frac{[Ag^+]^2}{[Ni^{2+}]}$$

$$= 0.80 - (-0.25) + \frac{0.059}{2} \log \frac{[Ag^+]^2}{[Ni^{2+}]}$$

i) $E = 1.05 + \frac{0.059}{2} \log \frac{1 x 1}{1} = 1.05$ V

ii) $E = 1.05 + \frac{0.057}{2} \log \frac{0.1 \times \cancel{0.1}}{\cancel{0.1}} = 1.0205$ V

iii) $E = 1.05 + \frac{0.057}{2} \log \frac{.01 \times .01}{0.1} = 0.9615$ V.

SOLUTIONS TO NUMERICAL PROBLEMS

UNIT - 11

Rate of Chemical Reactions

11.36 We know that Rate = $k(C_A)^x$ where k is the rate constant, x is the order of the reaction with respect to A and C_A is the concentration of A. Rate, as we know can be measured in mol L^{-1} s^{-1}.

$\therefore$ a) for a zero order reaction,

$$\text{Rate} = k\,(C_A)^0.$$

$\therefore$ (Rate in) mol L^{-1} s^{-1} - k (mol $L^{-1})^0$

of $k = \dfrac{\text{mol } L^{-1} s^{-1}}{(\text{mol } L^{-1})^0} = \text{mol } L^{-1}\ s^{-1}$

b) for a first order reaction,

$$\text{Rate} = k\,(C_A)^1_1$$

(Rate in) mol L^{-1} s^{-1} = k (mol $L^{-1})^1$

$$\therefore \quad k = \frac{\text{mol } L^{-1}\ s^{-1}}{\text{mol } L^{-1}} = s^{-1}$$

c) for a second order reaction ,

$$\text{Rate} = k\,(C_A)^2$$

$$(\text{Rate in})\ \text{mol}\ L^{-1}\ s^{-1} = k\,(\text{mol}\ L^{-1})^2$$

$$\therefore\quad k \text{ is } \frac{m\cancel{o}l\ \cancel{L}^{-1}\ s^{-1}}{m\cancel{o}l^{2}\ L^{-\cancel{2}}}$$

$$= \text{mol}^{-1}\ L\ s^{-1}$$

d) for a third order reaction,

$$\text{Rate} = k\,(C_A)^3$$

$$(\text{Rate in})\ \text{mol}\ L^{-1}\ s^{-1} = k\,(\text{mol}\ L^{-1})^3$$

$$\text{or unit of } k \text{ is } \frac{\cancel{m}ol\ L^{\cancel{-}1}\ s^{\cancel{-}1}}{mo\cancel{l}^{3}\ L^{\cancel{-}3}}$$

$$= \text{mol}^{-2}\ L^{+2}\ s^{-1}$$

e) for a half order reaction,

$$\text{Rate} = k\,(C_A)^{\frac{1}{2}}$$

$$(\text{Rate in})\ \text{mol}\ L^{-1}\ s^{-1} = k\,(\text{mol}\ L^{-1})^{\frac{1}{2}}$$

$$\therefore \quad k \text{ is } \frac{\text{mol L}^{-1}\ \text{s}^{-1}}{\text{mol}^{\frac{1}{2}}\ \text{L}^{-\frac{1}{2}}}$$

$$= \text{mol}^{\frac{1}{2}}\ \text{L}^{-\frac{1}{2}}\ \text{s}^{-1}$$

11.37 Rate = $k\ (SO_2Cl_2)^1$

a) $$\text{Rate} = \frac{1.5\text{x}10^{-2}}{60}\ \text{s}^{-1} \text{ x } 0.8 \text{ mol L}^{-1}$$

$$= .02\text{x}10^{-2} \text{ mol L}^{-1}\ \text{s}^{-1}$$

$$= 2.0\text{x}10^{-4} \text{ mol L}^{-1}\ \text{s}^{-1}$$

b) $$\text{Rate} = \frac{1.5\text{x}10^{-2}}{60}\ \text{s}^{-1} \text{ x } 0.04 \text{ mol L}^{-1}$$

$$= .001\text{x}10^{-2} \text{ mol L}^{-1}\ \text{s}^{-1}$$

$$= 1.0\text{x}10^{-5} \text{ mol L}^{-1}\ \text{s}^{-1}$$

c) $$\text{Rate} = \frac{1.5\text{x}10^{-2}}{60}\ \text{s}^{-1} \text{ x } 0.12 \text{ mol L}^{-1}$$

$$= .003\text{x}10^{-2} \text{ mol L}^{-1}\ \text{s}^{-1}$$

$$= 3.0\text{x}10^{-5} \text{ mol L}^{-1}\ \text{s}^{-1}$$

d) Rate = $\frac{1.5\times10^{-2}}{60}\ s^{-1} \times .01\ mol\ L^{-1}$

$= .025\times10^{-2}\ mol\ L^{-1}\ s^{-1}$

$= 2.5\times10^{-5}\ mol\ L^{-1}\ s^{-1}$

11.38 Rate $= k\ [C_{12}H_{22}O_{11}]^{1}\ [H_2O]^{0}$

$= k\ \ C_{12}H_{22}O_{11}$

at sucrose concentration 0.1 M, rate is 0.116 mol $L^{-1}s^{-1}$

$\therefore$ $0.116\ mol\ L^{-1}\ s^{-1} = k\ 0.1\ mol\ L^{-1}$

$$\therefore\ k = \frac{0.116\ \cancel{mol}\ \cancel{L}^{-1}\ \cancel{s}^{-1}}{0.1\ \cancel{mol}\ \cancel{L}^{-1}}$$

$= 1.16\ s^{-1}$

$\therefore$ At sucrose concentration 0.3 M,

Rate $= 1.16\ s^{-1} \times 0.3\ mol\ L^{-1}$

$= 3.48 \times 10^{-1}\ mol\ L^{-1}\ s^{-1}$

11.39 a) When 40% of H_2O_2 is decomposed, the remaining concentration of H_2O_2 is :

$$0.04 - \frac{0.04}{100} \times 40 \text{ mol L}^{-1}$$

$$= 0.04 - .016 = 0.024 \text{ mol L}^{-1}$$

This concentration represents a time lapse of 30 s (as per table)

$$\therefore \quad \text{Average rate} = \frac{(0.04 - 0.024)}{30 \text{ s}} \text{ mol L}^{-1}$$

$$= \frac{0.016}{30} \text{ mol L}^{-1} \text{ s}^{-1}$$

$$= 5.3 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

b) When 50% of H_2O_2 is decomposed, the remaining concentration of H_2O_2 is :

$$(0.04 - \frac{0.04}{100} \times 50) \text{ mol L}^{-1}$$

$$= 0.04 - 0.02 = 0.02 \text{ mol L}^{-1}$$

This concentration represents a time lapse of 40 s (as per table)

$$\therefore \quad \text{Average rate} = \frac{(0.04 - .02)}{40} \; \frac{\text{mol L}^{-1}}{\text{s}}$$

$$= 5.0 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

c) At 20 second after start, the concentration of H_2O_2 is 0.029 mol L^{-1}

$\therefore$ Average rate for 20 seconds $= \dfrac{0.040 - 0.029}{20} \dfrac{\text{mol } L^{-1}}{s}$

$= 5.5 \times 10^{-4}$ mol L^{-1} s^{-1}.

d) At 20 seconds and at 40 seconds after start, the initial concentration is 0.029 mol L^{-1} and the final concentration is 0.020 mol L^{-1}.

$\therefore$ Average rate for 20-40 seconds $= \dfrac{0.029 - 0.020}{20} \dfrac{\text{mol } L^{-1}}{2}$

$= 4.5 \times 10^{-4}$ mol L^{-1} s^{-1}

e) At 40 seconds after start, the concentration of H_2O_2 is 0.020 mol L^{-1}

$\therefore$ Average rate $= \dfrac{(0.040 - 0.020)}{40} \dfrac{\text{mol } L^{-1}}{s}$

$= 5.0 \times 10^{-4}$ mol L^{-1} s^{-1}.

SOLUTION TO PROBLEM

UNIT 13

Chemistry of Non Metals - II

13.70 Energy released in the process $\frac{1}{2} F_2(g) \xrightarrow{e} F^-_{(g)}$

$= \frac{1}{2}(158) - 333$ kJ mol^{-1}

$= + 79-333$ kJ mol^{-1}

$= - 259$

Energy released in tho $\frac{1}{2} Cl_2 (g) \xrightarrow{e} Cl^-_{(g)}$

$= \frac{1}{2}(246) - 349$ kJ mol^{-1}

$= 123-349$ kJ mol^{-1}

$= - 226$ kJ mol^{-1}

∴ Result shows that more energy -28 kJ mol^{-1} is released by F_2 .

SOLUTION OF NUMMERICAL PROBLEMS

UNIT : 17

PREPARATION AND PROPERTIES OF HYDROCARBO.

17.85 1 Kg. of coal sample contains:

$C = 0.75$ Kg. $H_2 = 0.052$ Kg. $O_2 = 0.128$Kg.

$S = 0.012$ Kg. $N = 0.037$ Kg. ash = 0.021 Kg.

The combustion equations are:

$$\underset{12}{C} + \underset{32}{O_2} \rightarrow CO_2(g);$$

$$\underset{2}{H_2} + \underset{16}{\tfrac{1}{2}O_2} \rightarrow H_2O(g)$$

$$S + O_2 \rightarrow SO_2(g)$$

∴ Minimum amount of oxygen required for combustion of C, H and S in 1 Kg. coal

$$= \begin{pmatrix}\text{Mass}\\ \text{of}\\ \text{C}\end{pmatrix} \times \frac{32}{12} + \begin{pmatrix}\text{Mass}\\ \text{of}\\ \text{H}\end{pmatrix} \times \frac{16}{2} + \begin{pmatrix}\text{Mass}\\ \text{of}\\ \text{S}\end{pmatrix} \times \frac{32}{32} - \begin{pmatrix}\text{Oxygen}\\ \text{in}\\ \text{fuel}\end{pmatrix}$$

$= 0.75\text{Kg.} \times (32/12) + 0.052\text{kg.} \times (16/2) + 0.012 \times (32/32) - 0.12\text{Kg}$

$= 2.0\text{Kg} + 0.416\text{kg.} + 0.012\text{kg.} - 0.12\text{kg} = 2.308$ kg.

Hence, the minimum amount of air required for complete combusion of 1 kg. of coal sample

$= 2.308$ kg. $\times (100/23)$

$= 10.035$ kg.

17.87 According to combustion equation: $\underset{(12)}{C} + \underset{(32)}{O} \rightarrow CO$

Weight of oxygen required by 1 Kg. of carbon$= \frac{32}{12} \times$

$= 2.667$ kg.

Now since 32 g of oxygen occupies 22.4 litres at STP

$\therefore$ 2.667 x 1000 g of oxygen will occupy $= \frac{22.4 \times 2.667 \times 1000}{32}$

$= 1866.9$ litres.

$\therefore$ Wt. of air (containining 21% oxygen) required

$= \frac{100}{21} \times 1866.9$

$= 8890$ litres.

$= 8.89\ m^3$.

SOLUTION TO NUMERICAL PROBLEMS

UNIT : 18

PREPARATION AND CHARACTERISATION OF ORGANIC COMPOUNDS

18.48 100 g of compound has 69 g of carbon

$$\therefore \; 0.2 \text{ g} \quad '' \quad '' \quad \frac{69}{100} \times 0.2 \text{ g}$$

12 g of carbon gives 44 g of CO_2

$$\therefore \; \frac{69 \times 0.2}{100} \text{ g} \quad '' \quad \frac{44 \times 69 \times 0.2}{12 \times 100}$$

$$= \; 0.5060 \text{ g}$$

100 g of compound has 4.8 g of hydrogen

$$\therefore \; 0.2 \text{ g} \quad '' \quad '' \quad \frac{4.8}{100} \times 0.2 \text{ g}$$

2 g of hydrogen gives 18 g of water

$$\therefore \; \frac{4.8 \times 0.2}{100} \text{ g} \quad '' \quad '' \quad \frac{18 \times 4.8 \times 0.2}{2 \times 100}$$

$$= \; 0.0864 \text{ g}$$

(1) Weight of CO_2 = 0.5060 g
(2) Weight of H_2O = 0.0864 g

18.49 $C_6H_5OH + O_2 \longrightarrow 6CO_2 + 3H_2O.$

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$

since each mole of phenol on complete combustion produces 6 moles of CO_2 ; and since each mole of CO_2 can produce 1 mole of $CaCO_3$.

∴ One mole of phenol on combustion will give 6 mole of $CaCO_3$. (1 mole of [illegible] = 94 g)

The molecular weight of $CaCO_3$ is 100.

Therefore 6 x 100 = 600 g of $CaCO_3$ will be formed.

∴ Amount of $CaCO_3$ formed = 600 g

18.50 Molecular mass of AgBr = 108 + 80 = 188

188 g of AgBr contains = 80 g bromine

∴ 1.8 g " " = 0.8 g "

Since one mole of the compound has 1 atom of bromine

∴ 1 g mole will have 80 g of bromine

0.8 g bromine is obtained from 1.57 g of compound

∴ 80 " " " " 157 g " "

∴ Molecular mass of the compound = 157

18.51 Molecular mass of $BaSO_4$ is 137 + 32 + 64 = 233

Thiourea molecule has only one atom of sulphur

$\therefore$ The weight of thiourea which will yield 233 g of $BaSO_4$ will be its molecular mass which is (12+32+28+4) = 76 g

i.e. 76 g of thiourea

18.52 18.6 g of phosphorus are present in 100 g compound

31 " " " " $\frac{100 \times 31}{18.6}$ g "

= 166 g

Therefore, molecular mass of the compound is 166

$12x + 15 + 48 + 31 = 166$

$12x + 94 = 166$

$12x = 166 - 94$

$= 72$

$12x = 72$

$x = 6$

$\therefore$ The value of x = 6.

18.53 The compound has only one - COOH group and no other functional group or element other than C, O, H. Therefore, its molecular formula can be written as CxHyCOOH.

C = 68.85% $$\frac{68.85}{12} = 5.74$$

H = 4.91% $$\frac{4.91}{1} = 4.91$$

O = 100 - (68.85 + 4.91)

= 100 - 73.76

= 26.24 $$\frac{26.24}{16} = 1.64$$

$$\frac{5.74}{1.64} : \frac{4.91}{1.64} : \frac{1.64}{1.64} \text{ is } 3.5:3:2$$

of C : H : O is 7 : 6 : 2

Therefore, the emperical formula of the compound is

$C\ H_6O_2$

Being a carboxylic acid, the emperical formula is C_6H_5COOH. Since there are only two oxygen atoms in the molecule, the molecular formula also is $C_7H_6O_2$ and therefore, molecular mass is 122, and the molecular formula is C_6H_5COOH

(1) Molecular mass = 122

(2) Molecular formula = C_6H_5COOH

18.54 Mass of C in the original sample is $\frac{1 \text{ mol C}}{1 \text{ mol } CO_2} \times 3.002 \text{ g } CO_2$

$$= \frac{12 \text{ g C}}{44 \text{ g } CO_2} \times 3.002 \text{ g of } CO_2 = 0.819 \text{ g}$$

Mass of hydrogen in original sample is

$$= \frac{2 \times 1.008 \text{ g H}}{18.02 \text{ g } H_2O} \times 1.640 \text{ g } H_2O$$

$$= 0.1835 \text{ g}$$

CO_2 and H_2O contain oxygen that came partially from the combined oxygen in the compound and partially from the air stream used in combustion.

$\therefore$ Oxygen content of the sample is : weight of sample -mass of carbon - mass of hydrogen

$$= 1.367 - 0.819 - 0.184 = 0.364 \text{ g}$$

$\therefore$ mole of C : H : O is

$$\frac{0.819}{12} : 0.1835 : \frac{0.364}{16}$$

$$= 0.0682 : 0.1835 : 0.0228$$

$\therefore$ the ratio of C : H : O

is $\dfrac{0.0682}{0.0228} : \dfrac{0.1835}{0.0228} : \dfrac{0.0228}{0.0228}$

$= 3 : 8 : 1$

$\therefore$ the umperical formula is C_3H_8O.

18.55 Moisture is 2.500 - 2.415 g = 0.085 g

Volatile matter is 2.415 - 1.528 g = 0.887 g

Carbon is 1.528 - 0.245 g = 1.283 g

ash is = 0.245 g

(It may be checked that the sum of all the figures above gives the original weight of the sample as 2.5 g)

% of moisture $= \dfrac{0.085}{2.500} \times 100 = 3.4\%$

% of volatile matter $= \dfrac{0.887}{2.500} \times 100 = 35.5\%$

% of carbon $= \dfrac{1.283}{2.500} \times 100 = 51.32\%$

% of ash $= \dfrac{0.245}{2.500} \times 100 = 9.8\%$

$$\text{or} \quad V_2 = \frac{96 \times 273 \times 38}{101.325 \times 300}\ \text{cm}^3$$

$$= 32.75\ \text{cm}^3.$$

22400 cm^3 of N_2 at STP weigh 28 g

$$\therefore\ 32.75\ \text{cm}^3\ \text{"}\quad\text{"}\quad\text{"}\quad \frac{28\ \text{gm} \times 32.75\ \cancel{\text{cm}}^3}{22400\ \cancel{\text{cm}}^3}$$

$$0.25\ \text{gm of the compound has}\ \frac{28 \times 32.75}{22400}\ \text{gm of Nitrogen}$$

$$\therefore\ 100\ \text{"}\quad\text{"}\quad\text{"}\quad\text{"}\quad \frac{28 \times 32.75 \times 100\cancel{\text{g}}}{22400 \times 0.25\ \cancel{\text{g}}}$$

$$= 16.37\%$$

18.58 Let the amount of excess acid be Vcm^3.

$$\therefore\ V_{\text{cm}}3 \times \frac{\cancel{N}}{4} = 77 \times \frac{\cancel{N}}{10} \quad \text{or}\ V_{\text{cm}}3 = \frac{77 \times 4}{10} = 30.8\ \text{cm}^3$$

$\therefore$ amount of acid neutralised by NH_3 is

$(50 - 30.8)\ \text{cm}^3 = 19.2\ \text{cm}^3$

$$19.2\ \text{cm}^3\ \text{of}\ \frac{N}{4}\ H_2SO_4\ \text{has}\quad \frac{49}{1000} \times \frac{19.2}{4}\ \text{gm of}\ H_2SO_4$$

$$= 0.2352\ \text{gm}$$

18.56 $P_1 = P$ kPa $\quad\quad$ $P = 101.325$ kPa

$N = V$ L $\quad\quad$ $V = ?$

$T = T$K $\quad\quad$ $T = 273$K

$$\frac{P\ \cancel{k}\text{Pa} \times V\text{L}}{T\cancel{K}} = \frac{101.325\ \cancel{k}\text{Pa} \times V}{273\cancel{K}}$$

$$V = \frac{P \times V \times 273}{T \times 101.325}\ \text{L}$$

The weight of this volume is w g

∴ 22.4 L of this vapour at STP (which is defined as its molecular mass) should weigh

$$= \frac{w \times T \times 101.325}{P \times 273 \times V\cancel{L}} \times 22.4\ \cancel{L}\ \text{g}$$

18.57 $P_1 = 96$ kPa $\quad\quad$ $P_2 = 101.325$ kPa

$V_1 = 38\ \text{cm}^3$ $\quad\quad$ $V_2 = ?$

$T_1 = 300$ $\quad\quad$ $T_2 = 273$

$$\frac{96\ \cancel{k\text{Pa}} \times 38\ \text{cm}^3}{300\cancel{K}} = \frac{101.325\ \cancel{k\text{Pa}} \times V_2}{273\cancel{K}}$$

$2\ NH_3 + H_2SO_4 = (NH_4)_2SO_4$

since 98 gm of H_2SO_4 is equivalent to 34 gm of NH_3,

∴ 0.235 " " " " $\frac{34\ \cancel{gm}}{98\ \cancel{gm}} \times 0.235\ gm$

= .08 gm of NH_3.

17 gm of NH_3 contain 14 gm of nitrogen.

∴ .08 " " " $\frac{14}{17} \times .08$ = .066 gm of nitrogen

∴ % of Nitrogen is $\frac{.0672}{0.24} \times 100 = 28\%$

18.59 188 gm of AgBr has 80 gm of Bromine

∴ 0.282 " " $\frac{80\ \cancel{gm}}{188\ \cancel{gm}} \times 0.282$ = 0.12 gm of Bromine

0.310 gm of the compound has 0.12 gm of Bromine

∴ 100 " " " " $\frac{0.12\ \cancel{gm}}{0.301\ \cancel{gm}} \times 100\ \cancel{gm}$ " "

= 39.86 % of Bromine

18.60 233 gm of $BaSO_4$ has 32 gm of sulphur

$\therefore$ 0.5825 " " " $\frac{32\cancel{g}}{233\cancel{g}} \times 0.5825\cancel{g}$

= .08 gm of sulphur.

0.2175 gm of the compound has 0.08 gm of sulphur

$\therefore$ 100 " " " " $\frac{0.08\cancel{g}}{2175\cancel{g}} \times 100 = 36.78\%$ of sulphur

18.61 $C = \frac{90}{12}$, $H = 10$ $\therefore$ C : H is 7.5 : 10

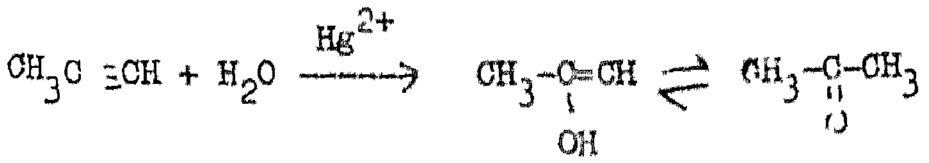
i.e. C : H is 3:4

$\therefore$ A is $CH_3C \equiv CH$.

$$CH_3C{\equiv}CH + 2HCl \longrightarrow CH_3-\underset{\displaystyle Cl}{\overset{\displaystyle Cl}{C}}-CH_3$$ (B)

Markownikoff's Rule

Hydration of A will give propanone



$$CH_3C{\equiv}CH + H_2O \xrightarrow{Hg^{2+}} CH_3-\underset{\displaystyle OH}{C}{=}CH \rightleftharpoons CH_3-\underset{\displaystyle O}{\overset{}{\underset{\|}{C}}}-CH_3$$

propanone

18.62 C : H is $\frac{92.3}{12}$: 7.7

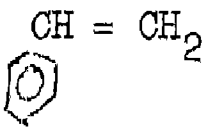
or C : H is 7.7 : 7.7 i.e. C : H is 1:1

∴ the emperial formula is C_nH_n

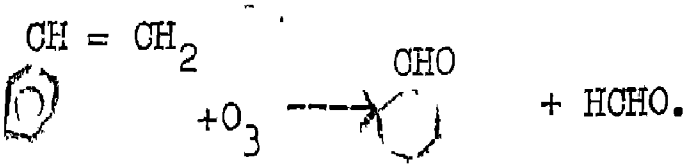
vapour density is 52.

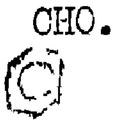
∴ molecular weight is 104.

∴ molecular formula is C_8H_8

∴ compound A is 

is i.e. styrene.

On ozonolysis 

∴ B is 

C is polystyrene